FEB 13 1911

February 14, 1911.

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POWER

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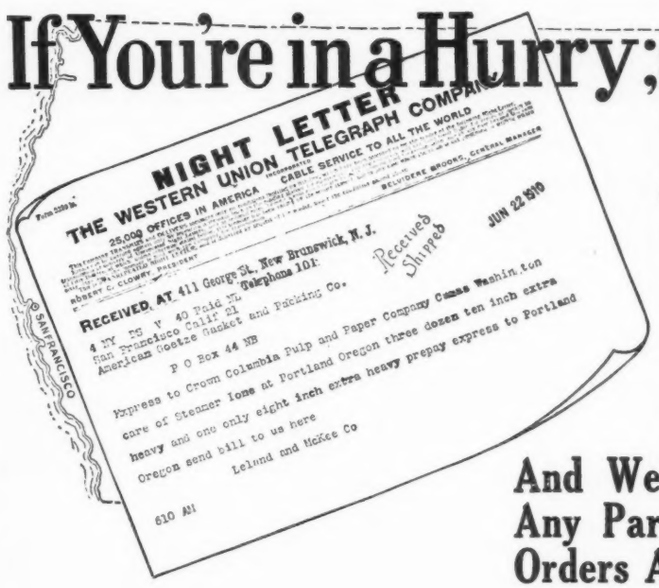
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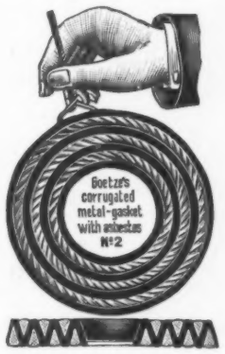

We'll Send You A Supply Of Goetze's Copper Asbestos Gaskets On 90 Days' Trial At Our Risk

No cure, no pay. "Goetze's No. 2" is an Elastic Corrugated Copper Gasket with Asbestos Lining. It's for flanged pipe joints. It will hold the highest of pressures and temperatures—even **highly superheated or saturated steam**—and in **long lines.** Goetze's Copper Valve Gaskets with Asbestos core are for valves of Jenkins or similar types. They will **give your old valves a new lease of life.** Many engineers put them right into their **new** valves, just to avoid trouble and save time with future replacements. Try either or both—at **our** risk. Try them **now.** By the way, have you our New Catalog of packings for All Power Plant Purposes? If not, ask for it.

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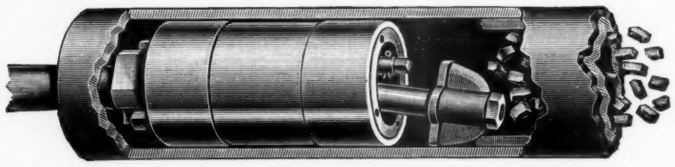
Power + Economy



The Dean Removing Scale from the Tube of a Water Tube Boiler.

Boilers are bought and paid for according to their rated H.P.

Rated H.P. depends on the extent of the heating surface.

Actual H.P. depends on the cleanliness of the heating surface.

A lining or covering of scale on the tubes will cause a loss of from 1/10 to 1/5 of the rated H.P.

Do you know how this works out in dollars and cents?

Let us give a concrete case and you may draw your own conclusions.

A certain boiler plant had 4 boilers, hard pushed.

"The only thing to do is to put in another boiler," suggested the engineer.

"Look here," said our salesman, who happened along about that time, "before doing that, try

The Dean Boiler Tube Cleaner

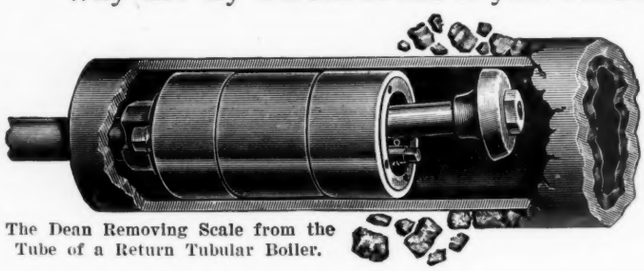
—won't cost you anything to try—maybe what you want is a clean heating surface and not a new boiler—a trial will set you right in the matter."

The Dean was tried—and sure enough, it wasn't a new boiler they needed but clean tubes.

And now 3 boilers, running easy, are doing the same work which formerly required 4!

Power plus economy—that's what the Dean gave; and that's what it will give *you*.

Why not try a Dean in one of your boilers and find out if *your* conditions can be improved?



The Dean Removing Scale from the Tube of a Return Tubular Boiler.

We don't ask you to purchase the Dean until you find out what it is worth to *you*.

But we know you'll never know just how valuable it is unless you try it.

Write for booklet 106 *which gives the testimony of users who have found the Dean a money saver.*

The Wm. B. Pierce Company

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POWER

NEW YORK, FEBRUARY 14, 1911

FOR over a year this page has been a feature of the paper. It was designed to bear a message to the man who is doing things or, at least, trying to do them.

Endeavor is made to make the language as near "human" as possible, and to point a moral or illustrate a truth in a way calculated to be emphatic as well as entertaining.

We are receiving regularly ample, unsolicited testimony that our efforts have met with approval. As soon as this ceases to be apparent this editorial leader will be dragged off to Barren island as a "dead one," and the space which it occupies will be given over to something more desirable to the readers. For, is not this the reader's paper?

Although the editor might get a wealth of comfort and enjoyment out of writing this weekly "whirl," yet would he have to forego it at the instant that the spectators turned down their thumbs on his handiwork.

And don't you know that what is true of the editor's work is just as true of yourown, no matter what your work may be? The instant that you stop "delivering the goods" you're on the greased slide and a swift slip to the discard is imminent.

A certain successful member of the race which is noted for business shrewdness was in the wholesale clothing business. One of his salesmen seemed to feel that every time he came in from a trip it was necessary to make elaborate explanations why the orders he had received were not more numerous.

So he would take up an hour or two of his employer's time telling how this man was all stocked up, and wouldn't buy; how that one was putting in a line of cheaper goods, and so on. Always the lack of orders was no fault of the salesman. Finally, toward the end of one of these sad seances, the manufacturer stopped the flow of excuses with the terse remark, "Well, Mr. Lowen, what we want is orders."

He might have said "results" and meant the same thing. Everywhere, in power-plant operation as well as in any other line of work, RESULTS are the things upon which a man's worth is based.

It makes no difference what you might, could, would or should have done, it is what you actually did do that tells.

In the long run, you are weighed by your work—not by your words.

Modern Boiler Plant, Holyoke, Mass.

By Warren O. Rogers

A central station, replacing three smaller boiler plants, reduced the operating expenses $75 a day. In the new plant the engineer can read the temperature of the flue gases, of return water from the mills and of the feed water, also the percentage of CO_2 in the flue gases without stepping from his office. The coal consumed is automatically weighed as it is conveyed to coal bunkers, and the weight is registered in engineer's office.

Present tendencies are to centralize the boilers and engines of manufacturing plants and use electric drive, especially where the buildings are scattered over a large area.

To secure the economies available through consolidation, the American Writing Paper Company, Holyoke, Mass., decided to erect a central steam-generating plant, of sufficient capacity to supply all the steam necessary to operate three separate paper mills, which were equipped with separate steam plants of from 600 to 1200 horsepower capacity.

This work was designed and installed by the company's engineering department under the direction of Edward P. Butts, chief engineer of the company. As a result, although aiming to keep the first cost down to a minimum, the plant stands a model for simplicity of design and ease of operation.

By means of this new plant the cost of operation, including labor, fuel and supplies, has been reduced $75 per day, or from $20,000 to $25,000 per year.

The boiler plant consists of six 400-horsepower Babcock & Wilcox boilers, based on 10 square feet of heating surface per horsepower. These boilers do the work formerly done by nineteen small boilers in the old plants. The boilers are operated constantly at 25 per cent. above their rating in order to obtain the best efficiency from them.

Murphy stokers are used, the grate area being 80 square feet, with a ratio of fifty to one. There has been no trouble in burning 30 pounds of coal per hour per square foot of grate surface and the plant operates practically with no smoke.

These boilers are set in three batteries, of two each, as shown in Fig. 1. A permanent iron stairway and rail has been placed at one end of the boilers and, as a platform extends the length of the boiler settings, the firemen can easily get at the coal chutes or fixtures on the front of the boilers.

In order to eliminate air leakage into the furnaces through the brick settings, the side walls of each battery have been lined with a magnesia covering. The tube blow-hole plates are fitted with a sheet-iron cover which prevents air leakage at these points. These features are shown in Fig. 2.

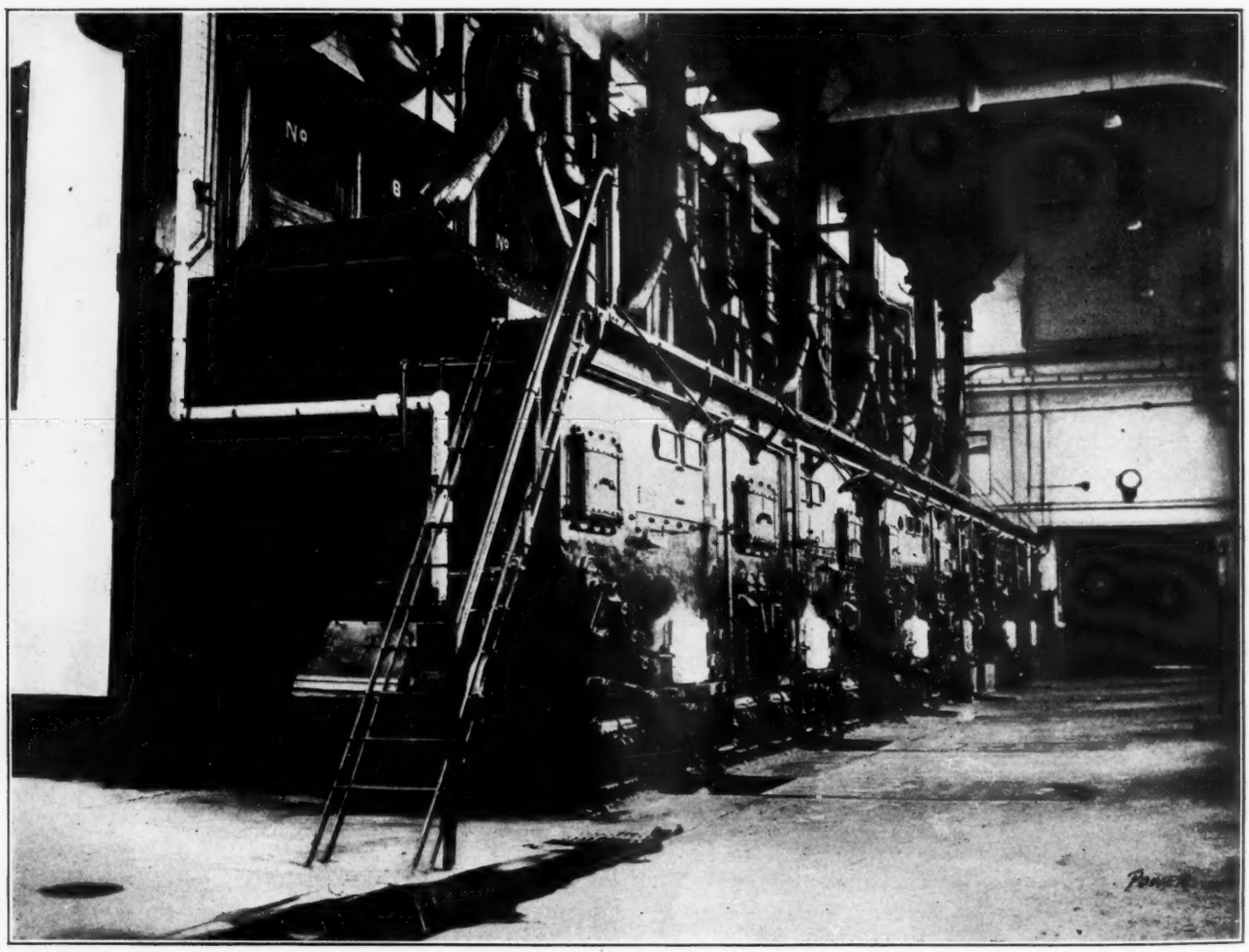


FIG. 1. NEW BOILER ROOM OF THE AMERICAN WRITING PAPER COMPANY

Each boiler smoke flue is fitted with a damper, but the draft is controlled by a main damper placed in the main smoke flue, between the stack and free operation. In order to prevent the damper sticking to the side and top of the smoke flue, a clearance of 1½ inches at the top and bottom has been allowed.

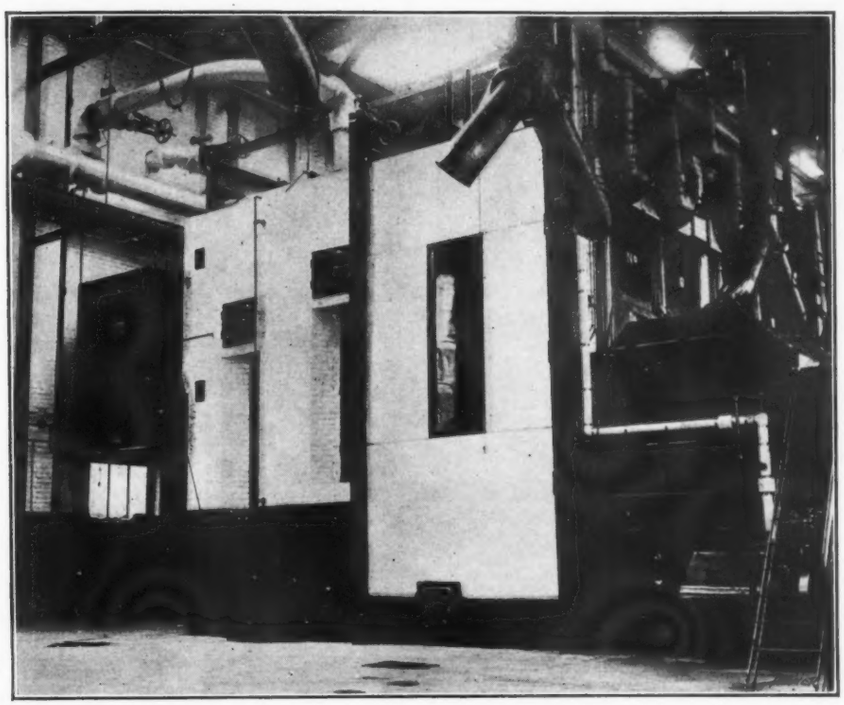


FIG. 2. SHOWING MAGNESIA COVERING ON BOILER SETTING

the junction of the individual smoke flues. This damper arrangement is peculiar, but effective. Instead of having a bearing on both sides of the smoke flue, the damper is suspended by means of an iron beam, placed crosswise over the top of the flue, an eyebolt, three large iron links and a short length of chain. The details are shown in Fig. 3.

The damper is connected to the damper regulator by means of a rod, as shown.

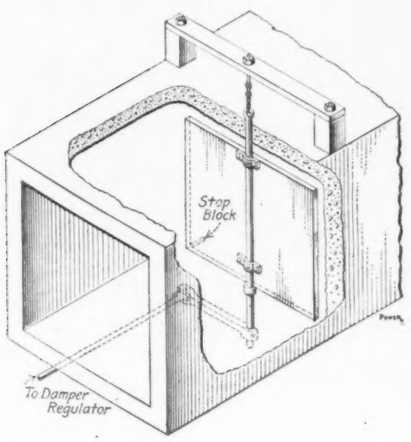


FIG. 3. DETAIL OF DAMPER ARRANGEMENT

Suspending the heavy damper on rings and chain has the advantage of allowing it to turn on a very small bearing point, thus eliminating friction and permitting

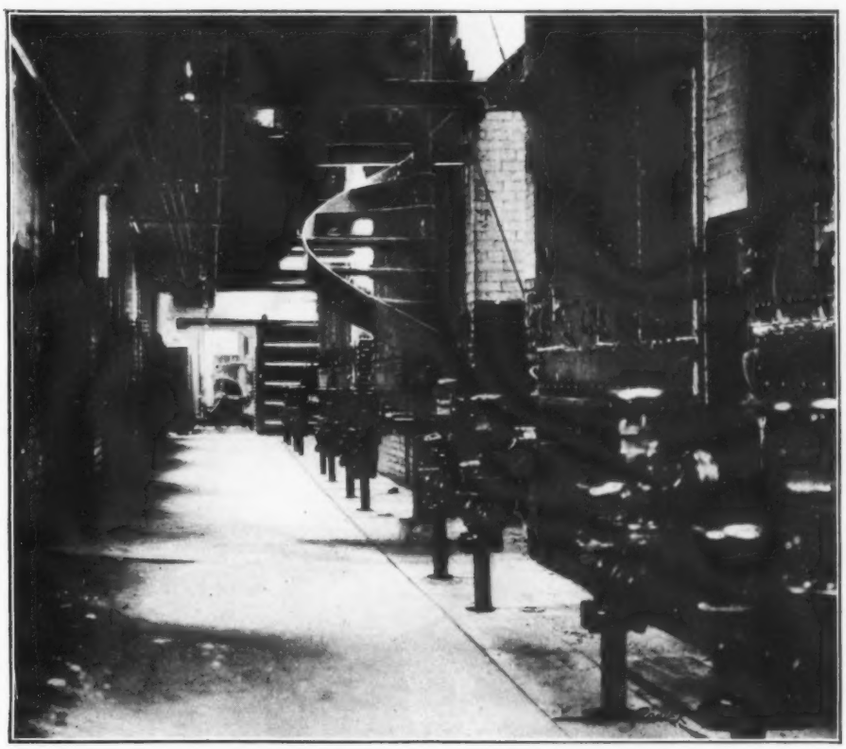


FIG. 4. VIEW BACK OF THE BOILERS

An iron stop is secured to the side of the smoke flue, and so placed that the damper rests against it before it is entirely closed. These precautions prevent any possibility of the damper sticking when closed and shutting down the entire plant.

Fig. 4 presents a view of the alley back of the boilers, showing the arrangement of the smoke flue, damper regulator on the wall and blowoff pipes, of which there are two lines for each boiler; double blowoff valves are used. An iron spiral stairway gives easy access to the top of the boilers.

These boilers generate saturated steam at 150 pounds pressure per square inch, although designed for 200 pounds with provision for using superheaters at some future time, should it be deemed advisable. Considerable thought was given to the subject of superheating the steam, which is carried to the mills several hundred feet distant, but as the steam was to be reduced to 100 pounds pressure for factory uses there was but little benefit, if any, to be derived from superheating at the boilers, and it was decided that the steam in passing through the reducing valves into receivers would be superheated to some extent. As it is, the steam goes to the factory in a dry state.

The ashpit of each boiler is made with a semi V-shaped bottom. This enables the fireman to hoe the ashes out into the 6-inch inlet pipe of the Darley vacuum ash-conveying system. The main ash tube, which is 8 inches in diameter and 170 feet long, empties into an ash tank located at one end of the building and above the top level of the boilers. A 14-ounce suction carried on the system

is maintained by a fan direct coupled to a Curtis steam turbine.

As the 6-inch inlet ash pipe is placed under an iron section of flooring outside

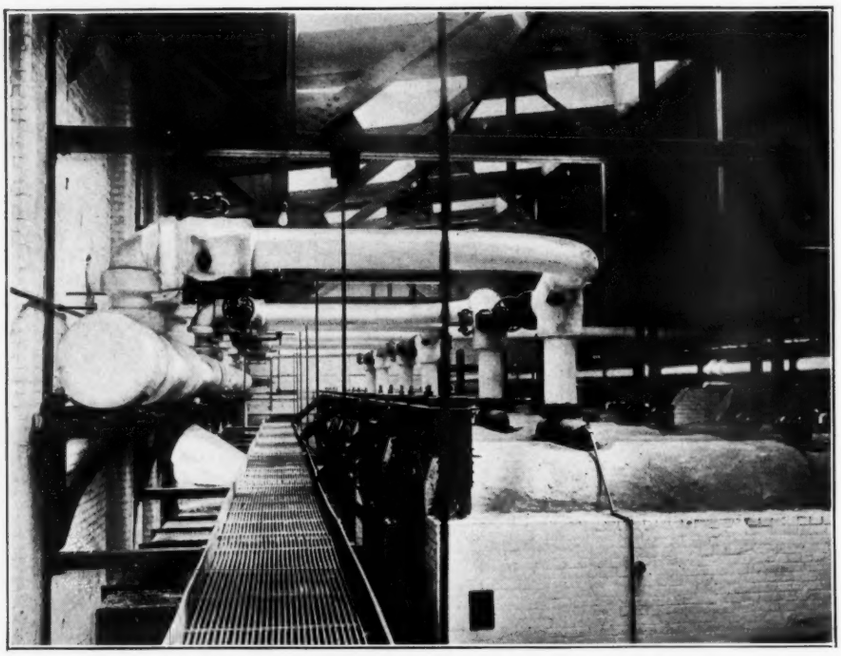


FIG. 5. LAYOUT OF PIPING OVER THE BOILERS

of the furnace fronts, it is necessary for the men to hoe the ash from the ashpit into the cement opening over the ash pipe. This pipe could have been placed under the ashpit, but it would have added to the cost of installing the system and also

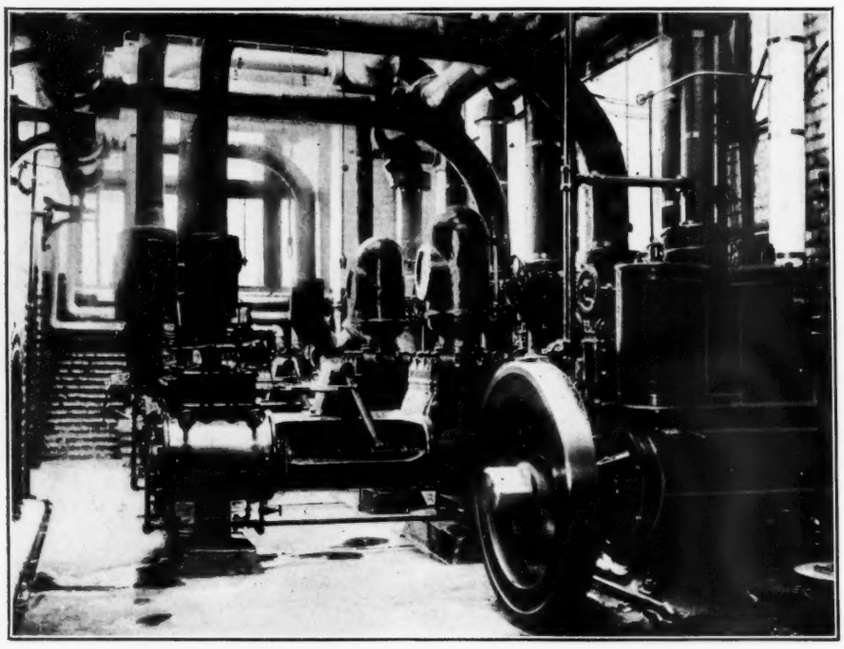


FIG. 6. AUXILIARY UNITS

loss of draft when the system was in operation, and with no additional saving in labor. This system was put in on a guarantee to handle 300 pounds of ash per minute, and it will handle anything that will go through a 6-inch pipe.

Figs. 2 and 5 give a good idea of the piping layout over the boilers. The flanges are screwed onto the pipe; the ends of the pipe are then peened over and faced. A walkway at the rear of the boiler extends the length of the boiler settings, and there are steps leading to the top of the steam drums.

Water may be fed to the boilers by means of either one of the two Deane 12 and 7 by 12-inch duplex pumps. Each is fitted with an air chamber to prevent pulsation in the Venturi meters. There is also a Worthington four-stage centrifugal pump, direct coupled to a Terry steam turbine, which runs at a speed of 2000 revolutions per minute. The turbine-driven pump is used 24 hours a day with an occasional shutdown while the duplex pumps are being tried out to be sure they are in running condition; they are kept as emergency units. A Westinghouse engine furnishes power to operate the coal-conveying system. These auxiliary units are shown in Fig. 6.

There are six concrete-lined steel coal bins over the boilers, each having a capacity of 20 tons. The construction of the lining of these bins is rather interesting. Owing to the deteriorating action of moisture and sulphur on steel, these bins are lined with cement. Channel irons are placed on the inside of the steel casing and held in place by bolts and nuts, as shown in Fig. 7. On the outside of the channel iron is placed a layer of wire lathing which is held in place by nuts. Over this iron lathing, and filling up the space between it and the outside steel casing of the bin, is a thick coating of concrete made of a one to three mixture of cement and sand, worked hard in order to get a smooth surface.

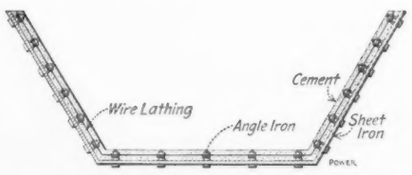


FIG. 7. CONSTRUCTION OF COAL BUNKER

Coal is delivered to these bins from either coal cars or from the reserve supply in the yard by means of a Robins belt conveyer. Fig. 8 illustrates the method of handling the coal. This belt conveyer is 250 feet long and is driven by means of a shaft which is belted to the 60-horsepower Westinghouse engine located in the pump room. The shaft is placed underground and also supplies power for the coal-crushing rolls. Fig. 8 also shows a coal car in position over the chute and hopper leading to the crushing rolls. After the coal is crushed it is elevated to the top of the conveyer tower and is either carried to the coal bins over the boilers or is discharged onto the reserve pile in the yard, where about 2000 to 3000 tons are kept on hand for emergency. The coal flowing from the bins to the stokers through iron chutes regulates itself, as the supply banks up in the spouts as soon as sufficient coal has run down.

When it is desirable to discharge the coal into the yard, the *A* frame controlled from the yard level and shown in Fig. 8, is placed above the point where it is desired to dump the coal, and the unloading device on the conveyer set so that the coal will be discharged on both

sides of the belt. Under the conveyer shed is a line of hoppers leading to an underground conveyer so that the supply in the yard can be elevated and carried to the boiler room. When the coal in the immediate vicinity of the opening has been used the outlying coal must be shoveled into the underground hopper or moved in some other way.

To reduce this labor to a minimum a portable conveyer, made something as shown in Fig. 9, is used. It consists of a long framework set on a pair of iron wheels. A 3-horsepower motor is suspended and boxed in under the frame. The belt conveyer and supporting rolls are placed on top of the framework, the belt running over rollers placed at each end of the frame. One roll shaft is fitted with a sprocket wheel which is belted to a similar wheel on the motor shaft. A stationary hopper is fixed at one end of the frame into which the coal is shoveled.

When in use, the hopper end is placed farthest from the underground conveyer and the portable conveyer set in a horizontal position. Six men can shovel into the hopper and the belt will take care of the coal without trouble. This device saves considerable labor in case coal from the outer edge of the coal pile must

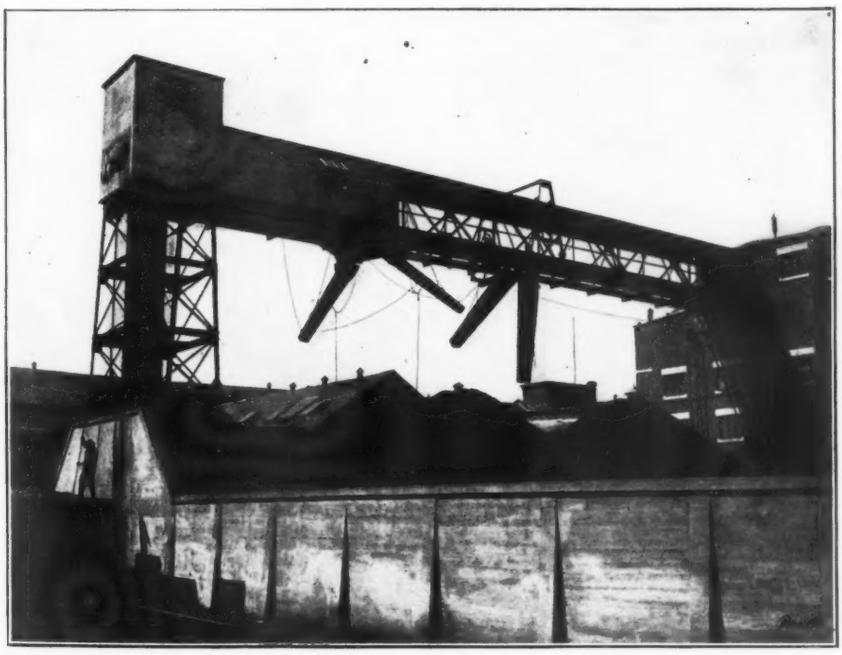


FIG. 8. COAL CONVEYER AND COAL-STORAGE YARD

be used. The belt runs at a speed of about 200 feet per minute.

The coal is weighed on a Merrick scale or weightometer, and a Merrick coal-weight recorder is placed in the operating engineer's office, each dial representing 200 pounds, 2 tons or 10 tons. A record is made by a pin on a revolving disk on the scale, closing a circuit and causing an electrical current to pass through a magnet coil which draws an armature down and revolves the first unit of the counter, and for every contact made the register is advanced one number, as in the case of a revolution-counting recorder. The accuracy of this combination scale and record is apparent when it is stated that a difference of only ½ of 1 per cent. was found in weighing thirteen million pounds of coal as invoiced by the shipper. An average of 15,000 tons of Clearfield coal, containing 14,000 B.t.u. per pound, 9 per cent. ash and 1¾ per cent. sulphur, are burned per year.

Above the boiler and overlooking the firing alley is the operating engineer's office. Here are placed the recording instruments which enable him to tell at a glance the temperature of the flue gases from each boiler and also of the gases in the main flue; temperature of the return water from the mills through the various pipe lines, the steam pressure carried and the amount of water being used.

Fig. 10 shows one corner of the office and the board on which the temperature-recording instruments are mounted.

The top central dial is the clock; the two small gages at each side are the feed-line pressure gage and vacuum gage on the ash vacuum system. At the left is shown a combination steam and recording gage, and at the right of the board is shown the draft-recording gage. The switch arrangement at the bottom of the board represents an arrangement that is

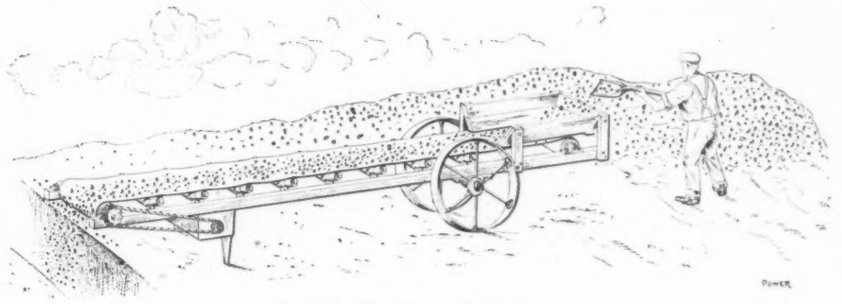


FIG. 9. PORTABLE CONVEYER

unique in every detail. The switches are for the purpose of closing a circuit between the electric couples on the return hot-water line, feed-water lines, uptake for each boiler and the main smoke flue. These switches are of the double-throw type because it is the intention to install continuous recording instruments at some future date.

The Wilson-Maculen Company designed the present system. It consists of two Wilson electric indicating instruments, shown just below the two larger recording gages. One terminal of each instrument is connected to a line leading to the electric couple; the other terminal of each instrument is connected to the upper contact jaw of the switch of the couple to be tested. The center or pivot post of the switch is connected to the grounded end of the electric couple.

All that is necessary in order to ascertain the temperature of any return line or uptake temperature is to throw the switch corresponding to the right electric couple so as to form an electric circuit through the indicating instrument. No two couples can be connected to the instrument at one time, so the chances of error are entirely eliminated, in case two or more switches should be thrown at the same time. The couples on the water lines are of the compound type; the temperature of the flue gases is obtained by simple couples. There are three return water lines from the mills and two feed lines to the boilers, one being used as an emergency line. The thermo-couples for the flue gases are located in the main flue at the rear of each boiler. The average temperature of the main-flue gases is 500 degrees Fahrenheit.

A feed-water temperature of 185 degrees is obtained after passing the feed through a heater. With a temperature of 80 degrees on the grounded end of the thermocouple the readings for the various boilers vary but 25 degrees for

all seasons of the year, but simple adjustments for season change reduce the variations in the readings to 5 degrees.

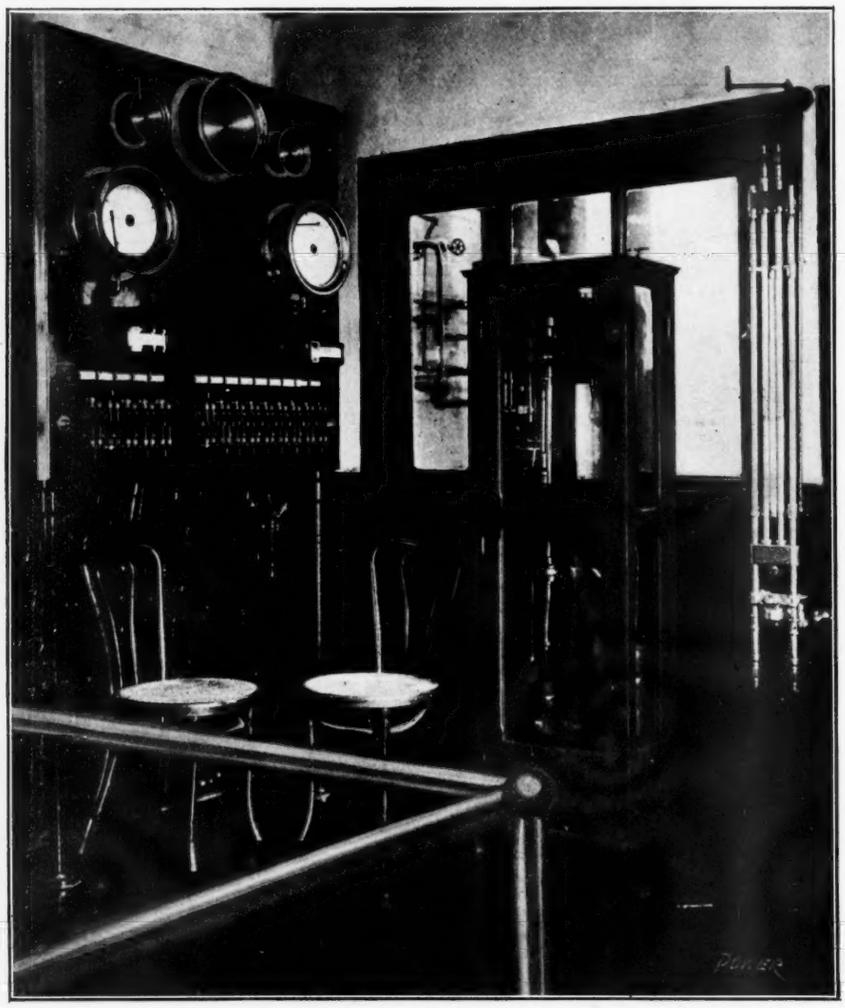


FIG. 10. PARTIAL VIEW OF ENGINEER'S OFFICE

The water consumption for the six boilers runs as high as 100,000 pounds per hour, this volume fluctuating with the stage of water supplied to the water-

plant is recorded by a Venturi water meter that is located in the office. The chart scale is graduated into thousands of pounds per hour, and the total amount is measured by a planimeter on daily charts. Each feed line is equipped with a Venturi meter and a third meter is connected to a bypass feed line, as shown in Fig. 11. This allows running any one boiler on a test, and the amount of water used is

metered without interfering with the total amount of water passing through the meter in the main feed line. For instance, suppose all of the water being used by the boilers is being passed through the meter on feed line No. 1. If a test is to be made on a single boiler, the valve on feed line No. 1 between the meter and the boiler to be tested is closed and the regulating valve on feed pipe No. 2 opened. The valves *A*, *B*, *C* and *D* are open and valves *E*, *F* and *G* closed. The flow of water to the boiler being tested would be through the main feed line No. 1, the meter *M* and valves *A* and *B*, meter *N* and valves *C* and *D*

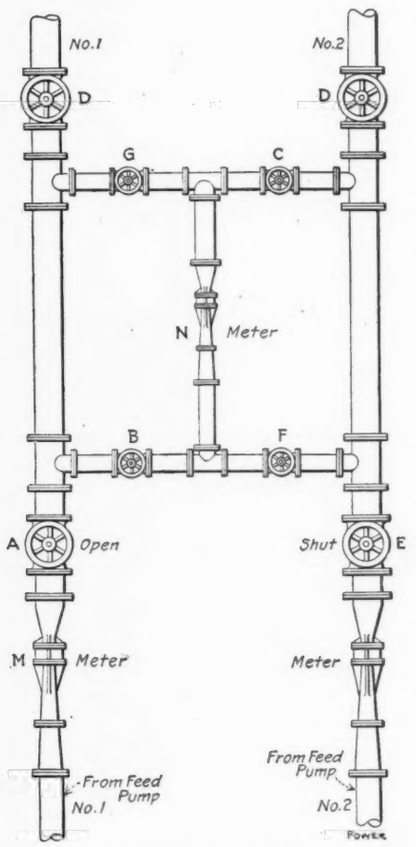


FIG. 11. ARRANGEMENT OF METERS AND FEED PIPES IN PUMP ROOM

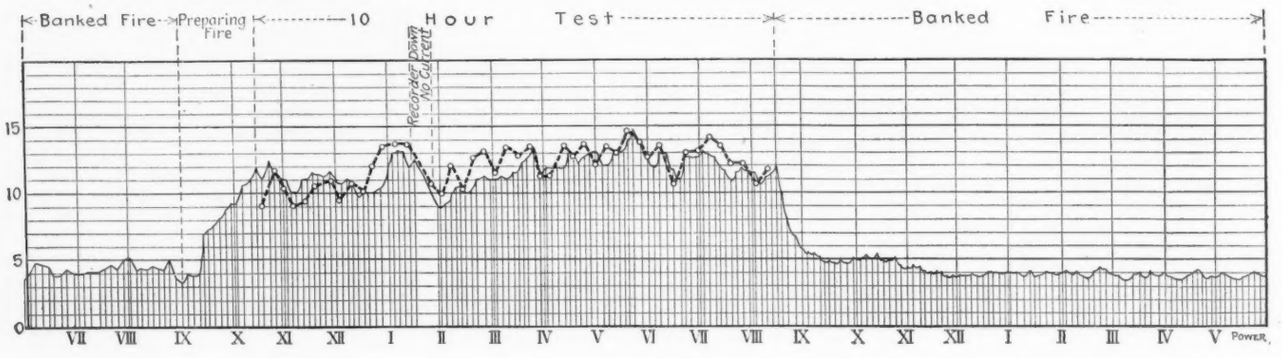


FIG. 12. COMPARATIVE RECORDS OF CO_2 CONTENT IN FLUE GASES

wheels, with which the three mills are equipped.

The amount of water consumed in the

BOILER TEST.

AMERICAN WRITING PAPER COMPANY,

DEPARTMENT OF MANUFACTURING AND MAINTENANCE.
HOLYOKE, MASS

Date June 21, 1910

MADE BY E.L. Small & J. R. Fortune
AT Central Boiler Plant "A"
ON BOILER No 2 - B & W. 196 - 4" tubes 18'-0" long, 3 drums 42"dia x 20'-4"lg.
TO DETERMINE Efficiency of Murphy Furnace.
KIND OF FUEL (Empire) Bituminous Coal
KIND OF FURNACE Murphy Stoker.

METHOD OF STARTING AND STOPPING		Alternate				
GRATE SURFACE	Sq. Ft.	64 or 80				
WATER HEATING SURFACE	" "	4000				
TOTAL QUANTITIES						
Date of trial		6-21-10				
Duration of trial	Hrs.	10				
Weight of coal as fired	Lbs.	20220				
Percentage of moisture in coal	%	7				
Total weight of dry coal	Lbs.	18804				
Total ash and refuse	Lbs.	1694				
Percentage of ash and refuse in dry coal	%	9				
Total weight of water evaporated	Lbs.	198893				
Factor of evaporation		1.0968				
Equivalent evaporation from and at 212 degrees, corrected	Lbs.	218145				
HOURLY QUANTITIES						
Dry coal consumed per hour	Lbs.	1880				
Dry coal consumed per hour per sq. ft. grate surface	Lbs.	23.5 or 29.38				
Evaporation per hour from and at 212 degrees	Lbs.	21814.5				
Evaporation per hour per sq ft water heating surface	Lbs.	5.45				
AVERAGE PRESSURE, TEMPERATURE, ETC						
Steam pressure by	Lbs.	144				
Temperature of feed water	Deg.	165				
Temperature of escaping gases	Deg.	570				
Force of draft in Front .249, Back .568	Inches of water					
Per cent. of CO_2 in gases Inside of back nipples	%	12.1	Average of	45	samples	
Per cent. of CO. in gases	%	0.3	" "	21	"	
Per cent. of O. in gases	%	7.2	" "	21	"	
HORSE POWER						
Horse power developed	H. P.	631.				
Builders rated horse power	H. P.	400				
Per cent. of builders rated horse power developed.	% H. P.	157				
ECONOMIC RESULTS						
Evaporation at 212 degrees per pound of coal dry	Lbs.	11.60				
Evaporation from and at 212 degrees per lb combustible.	Lbs.	12.75				
COST OF EVAPORATION						
Cost of coal per ton in boiler house	$					
Cost to develop 100 horse power.	$					

REMARKS:

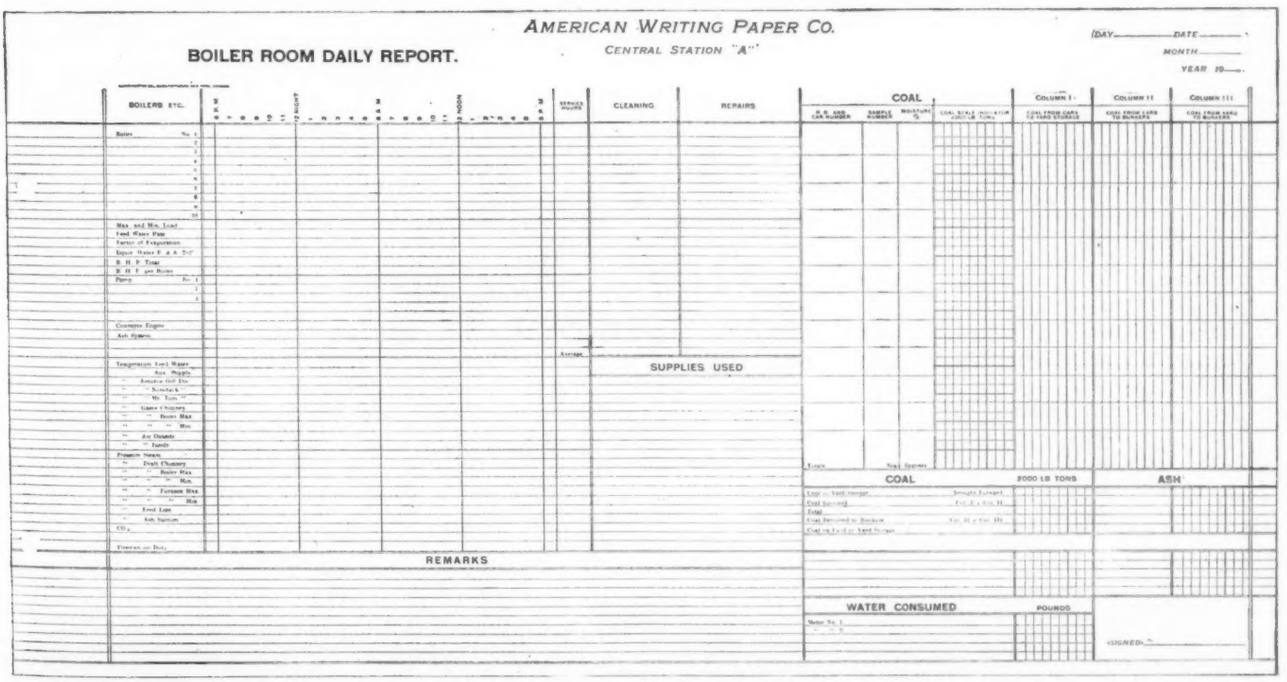
to the feed line No. 2 and into the boiler. This allows the entire amount of water used in all boilers to pass through the meter *M*, but the water used in the boiler being tested passes through meter *N*, so that its water consumption can be accurately metered. The mercury gage for the small Venturi meter used on this test is located in the office, as shown in Fig. 10.

A Westover CO_2 recorder, placed in the office, registers the performances of the furnaces. Fig. 12 shows a performance worthy of notice, and represents a ten-hour test that was run to determine the CO_2 content of the flue gases. The continuous lines denote the record obtained from the Westover recorder and the heavy line on which the circles appear represents the time of taking and the percentage of CO_2 obtained from a hand Orsat recorder. Forty-five samples of gas were taken just inside of the back nipples of the boiler, during the ten-hour test. The average of the CO_2 record of the Westover recorder shows 11.73 per cent. and that of the hand Orsat 12.10 per cent.

The accompanying boiler test gives a good average of the boiler performance at the time of the test.

A reproduction of the boiler-room daily report sheet is shown below. These sheets are bound in book form with two colored sheets, one for filing with the chief engineer, the other a carbon copy to be filed by the operating engineer. The daily report sheet is 14x24½ inches.

It is so ruled and tabulated that scarcely any explanation is necessary for the reader to understand. The spaces devoted to coal under columns I, II, and III enable the engineers to determine the amount of coal on hand at the end of each day's run. Under column I, record is made of the coal conveyed from the coal car to the yard; column II is a record of the coal taken from the car and conveyed to the coal bins over the boilers, and column III is a record of the coal taken from the yard to the bunkers. By



AMERICAN WRITING PAPER CO

BOILER ROOM WEEKLY REPORT — CENTRAL STATION "A" — WEEK ENDING _____ 19__

	BOILERS, ETC.	SERVICE HOURS	CLEANING	REPAIRS	SUPPLIES USED	REMARKS
	Boiler No. 1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	Total for Week					
	Pump No. 1					
	2					
	3					
	Conveyor Engine					
	Ash System					

		COAL	2000 POUND TONS	MOISTURE	ASH
Feed Water Temperature Average for Week		Coal on Hand from previous week			
Steam Pressure " " "		" received present week			
Factor of Evaporation		" on hand in Yard Storage			
Water Evaporated Total " " Pounds		" " " " Bunkers			
Equivalent Evaporation F. & A. 212° "		Coal Burned present Week			
" " " " per lb. coal as fired					
Boiler H. P. Maximum load developed					
" " Minimum " "					
" " per boiler mat. " "					
" " " " average load developed				SIGNED: _____	

adding the amount of coal taken from the cars and that taken from the yard the total amount consumed during the day is determined, and deducting the amount of coal taken from the yard, the total amount in the yard as indicated from the previous report is ascertained, which is carried on for each day's report to the next and shows the total amount of coal in storage. Therefore, there is no guess work as to the amount of coal in the yard at the end of any day's run.

The weekly report is a condensation of the daily report, and is made on 8½x19-inch sheets. In case any particular item is in question, it is easily checked by referring to the daily report sheets of the same dates given on the weekly report sheets. These report sheets are perforated at one end, making it easy to tear out of the book. They are also punched for placing in a binder so that the sheets may be readily filed.

The foregoing information and illustrations were obtained through the courtesy of Edward P. Butts, chief engineer of the company.

Central Station vs. Factory Plant

By Henry D. Jackson

Two instances in which the conditions were such that although the tentative figures submitted by the central-station management were in their favor, the actual results proved that a greater saving would have been effected by the installation of individual plants.

For the past few years, central-station men have been making a considerable stir regarding the possibilities of economy in the operation of factory plants through purchased power, the argument being that the central station—owing to the character of its load, type of machinery and the location of its plant—could produce and deliver power to the manufacturing plant at a lower price than a manufacturing plant could generate it.

The central-station men take the stand that the use of exhaust steam for heating, or for any other purpose, has no material bearing upon the cost of power. They usually contend that the back pressure necessitated by the heating system is so great that the increased steam consumption by the engine more than neutralizes the gain which might be obtained through the use of this steam for heating purposes; in other words, they claim that it is fully as cheap, and in some cases cheaper, to heat by steam direct from the boiler than by exhaust steam from the engine. Although this may be true under certain conditions, it is by no means true in many cases, particularly in those plants requiring the use of steam in any considerable quantity for heating and other purposes, where low-pressure steam can do the work.

A properly arranged heating system will not put back pressure on the engine, and where a plant is operating condensing, it is sometimes possible to operate a vacuum system of heating, utilizing the exhaust steam from the engine and reducing the vacuum of the condenser to a point which will allow sufficient steam to flow through the heating system. This, however, is available in comparatively few plants, as the gain thereby is not sufficient to warrant it.

An example of central-station engineering recently came to the writer's attention in a plant requiring considerable power for operating its machinery and for lighting. The central station made the claim and apparently substantiated it with figures of its own making, to prove that it would be more economical to operate with electric drive—the power to be furnished by the lighting company—than with the original belt drive. The owners were convinced of the advisability of the change and installed the electrical equipment, apparently under the engineering advice of the central station. To the great astonishment of the owners, after the installation was complete, the cost of operating the factory, instead of decreasing, increased to a very marked extent. It was at first supposed that increased production was the cause of the increased cost, but a comparison of the output soon showed this to be untrue; the production was less but the cost greater.

Numerous attempts were made to locate the trouble but without success until a few carefully made tests throughout the factory and a thorough examination of the conditions existing about the installation, showed that while a large amount of heavy shafting and countershafting had been removed with its attendant friction, the actual friction power was still far in excess of what it should have been in a properly laid out electric drive. The rooms were low studded and the shafting was quite close to the ceiling, so that the permissible diameters of the pulleys were restricted. The motors were of the highest speed obtainable, in most cases, to reduce first cost. The ratio of pulley diameters was far too

great for the economical transmission of power, and the exceedingly small motor pulleys and short centers required a very heavy belt tension which deflected the shafting itself; this deflection naturally caused a heavy friction loss throughout the entire line shafting.

It was further found that much of the machinery, which was intermittent in operation, would not operate satisfactorily, owing to the excessive slip on the small motor pulleys when the machines were put into service. In other cases where the shafting was run along the floor, motors were hung on the ceiling underneath, the belts running through the floor to the shafting. The ratio of pulley diameters was about 5 to 1, the motor pulleys being approximately 3 inches in diameter and the distance between centers about 3 feet. The friction loss on these particular shafts was about 98 per cent. of the total power required to operate when the machinery was in service. In many cases throughout the factory, the friction power required to drive motors and shafting was over 75 per cent. of the average power required. A careful study of all the conditions showed that the power required to operate the shafting and motors alone was considerably over 50 per cent. of the total power required to operate the factory under full-load conditions.

Further study showed that had the electric company agreed to furnish power for one-half of its regular charge, the total cost of operating the plant, including heat, would have been practically the same as that which existed with the original belt drive; also, that a change in the methods of drive would result in a marked decrease in the friction loss; and as steam was required for heating purposes practically the year round, the plant could generate its own power for approximately one-half that which the lighting company could furnish it. Hence, under the conditions of decreased friction, the plant could generate its own power and utilize it throughout the factory with a considerable saving over the old belted installation. The figures included all of the fixed charges on the plant, as well as all of the operating charges.

A few instances of waste power were discovered, which could readily be remedied, among them being one place where forced circulation of air was used for drying purposes. A comparatively inexpensive change in the arrangement of the drying outfit would do away entirely with the use of power. It was also found that certain pieces of apparatus which were used all day were connected across the lighting circuits and might readily be put on the power circuits. There was, however, a difference in the charge for light and power of approximately two to one, so that it was to the advantage of the central station to have these pieces of apparatus on the lighting circuit.

Another instance which came to the writer's attention was in a comparatively large establishment, to which power was offered for approximately $40 a horsepower-year of 3080 hours, and an attempt was made to show that power was costing the owners considerably more than this figure. A study of this plant showed, to the contrary, that power was costing them far less than $40 a horsepower-year. This surprised the owners and also the lighting company. The reason for it, however, was plain enough; in the first place, at least double the amount of steam was required for various purposes throughout the plant that was required for power production. The temperatures required were such that exhaust steam or low-pressure steam was effective, so that the engines used did not need to be bought for steam economy and were not, and this heat was required the year round. Furthermore, waste material from the plant which could be sold for practically nothing could, to a large extent, be utilized for fuel; in fact, for many days out of the year little or no coal was used, so that the fuel bill was exceedingly small. The cost of the installation itself was low, the attendance was small compared to the size of the plant, and as a result the total power bill per horsepower-year was considerably under that which could be offered by the electric company.

In their figures, the electric company took the stand that the coal required was approximately four pounds per horsepower-hour, that the steam plant cost in the neighborhood of $100 per horsepower, and that the attendance on the basis of a plant operating twenty-four hours a day, also interest, maintenance and depreciation, were figured at excessive rates.

These are two of the most glaring instances the writer has yet come across, but there are numerous other instances where the management of a central-station plant has made use of figures which were hardly reliable and made claims of being able to furnish power at prices which the owners could, if they but knew how, readily prove to be exorbitant.

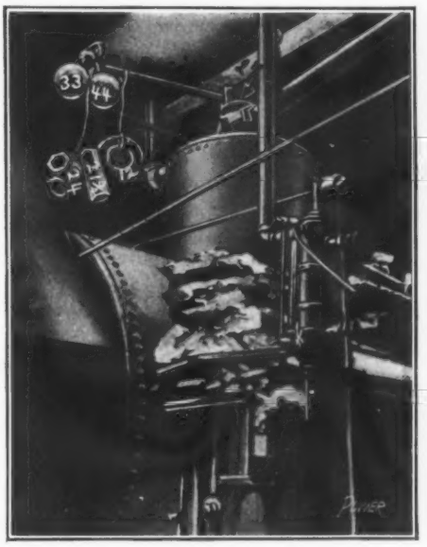
There are many plants which can profitably buy power from a central station, but there are also many plants where the central station cannot afford to make a price which the owner should listen to. These are due very largely to local conditions, but they exist in practically every locality where power is sold. No manufacturer can afford to neglect the cost of heating, either for his buildings or for special processes in manufacturing as a part of the operating cost of his plant; and when a central station offers power at what seems to be an exceedingly low rate, he should take into account when making a comparison, what it costs him to purchase power and supply all of the heat required, as compared to what it will cost him to operate his own plant, supplying all the heat required. If he is not capable of making this comparison in a thoroughly accurate manner, he should employ someone who can. It should be noted particularly that in making these comparisons, it is absolutely essential that every item entering into the cost be figured, such as labor, coal, water, oil, taxes, interest, maintenance, depreciation, etc.

Loaded Safety Valve

By M. Osborn

Michigan has been responsible for a great many interesting engineering combinations, and the one illustrated herewith is another of which she will have to take the responsibility.

Anyone interested can figure out at



Weighted Safety Valve

what pressure the safety valve, shown in the accompanying illustration, will blow with 134¾ pounds weight on the lever that has a length of 3 feet 10 inches, a fulcrum of 2¼ inches, and a valve diameter of 2½ inches. In making the calculations it will, of course, be necessary to neglect the possible effect of corrosion resulting from long continued inactivity.

John Brown & Co., Ltd., of Clark Bank, the builders of the "Lusitania," the "Carmania" and the "Caronia," have received an order from the Cunard company for a new Atlantic liner exceeding in power and dimensions the "Olympic" and "Titanic," being built by Harlan & Wolf, of the White Star Line. The design has not yet been finally settled but *Engineering* gives the probable dimensions at about 885 feet over all, about 50,000 tons gross register, and 50,000 to 60,000 shaft horsepower, which is expected to give a free speed of 23 knots in service. The machinery will be of the turbine type, driving four shafts and screws.

Piping Layout of Closed Heaters

By W. H. Wakeman

The exhaust steam for heating the feed water is led into the main heater and the surplus steam then carried over to an auxiliary heater supplying water for manufacturing purposes.

In Fig. 1 are shown two closed heaters located in a shop where considerable steam is used for heating water for manufacturing purposes, in addition to the boiler supply. It is necessary to use more or less live steam for this purpose, but inasmuch as it takes only about one-sixth of the exhaust steam from an engine to heat the feed water, there is a large surplus which can be used for other purposes. No special advantage is gained by the use of two heaters, as the same results may be secured with one if large enough to do the work. However, it should be fitted with two independent coils so that it will be impossible for employees of the shop to use water which the engineer needs for the boilers.

Where two heaters are in service it is often because of the fact that only one was formerly used, and that the demands for hot water had increased until this was no longer sufficient for the purpose, resulting in its being taken out and a larger one substituted and the old one connected up afterward in order to use all of the exhaust steam. In the present case, exhaust steam passes through the larger heater, and what is left is prevented from going directly to the atmosphere by the back-pressure valve. Therefore, it passes to the right, through a pipe which projects through a brick wall, beyond which there is a tee connecting with a smaller heater; this has no outlet on the bottom except a drip for removing water of condensation. Steam passes readily into a heater piped in this way, because water passing through the coil condenses some of the steam and creates a partial vacuum; more steam rushes in to fill this space and the supply is maintained as long as there is any steam passing through the horizontal pipe. If any is left it passes on to be used for other purposes.

There are at least two ways for connecting the water pipes of such a system, the better of which is here shown. Water from the pump passes to the bottom of the large heater and coming out at the top is conducted through the upper pipe to the boilers. This insures hot water for the boilers as long as the engine sends enough exhaust steam through the first heater. Entering near the bottom of the smaller heater, the water for manufacturing purposes passes upward and out near the top, then enters the right-hand side of the larger heater. A separate coil is provided for this water and the outlet is on the same side near the top, whence it passes to the shop as indicated.

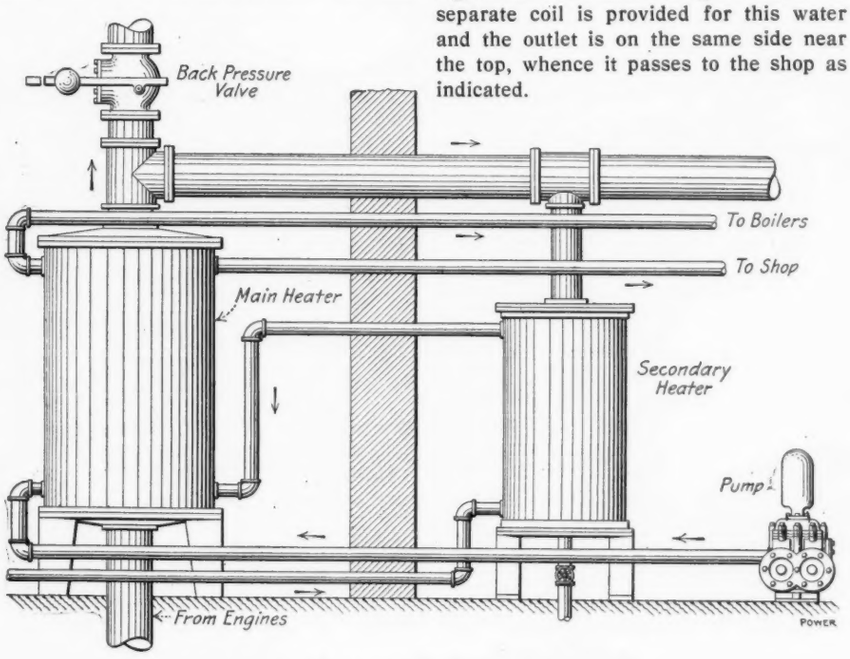


FIG. 1. MAIN AND SECONDARY HEATERS

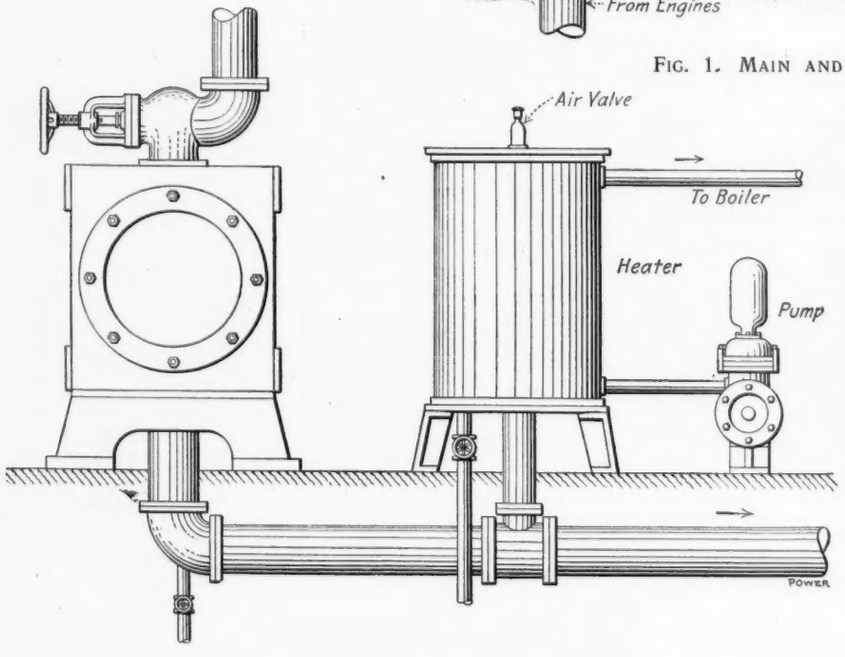


FIG. 2. A COMMON ARRANGEMENT OF PIPING HEATER TO ENGINE

The engineer of the plant laid out this arrangement of piping, and insisted upon its adoption, although it was not favored by the superintendent; the latter wished to have water for the shop service go into the larger heater before it went into the smaller one. The reason for this difference of opinion is evident. The engineer's plan insures hot water for the boilers, and if there is not sufficient exhaust steam to supply everything, the shop service fails to obtain the required heat. The superintendent's plan would insure hot water for the shop service, and lack of exhaust steam to fill all demands would result in sending comparatively cold water into the boilers. As a rule, it is better to introduce the cold water into a heater near the point at which the exhaust steam escapes, but this is ignored where it would necessitate the use of extra piping and fittings.

Fig. 2 illustrates a neat arrangement for a heater which is used for the boiler-

feed water only. The exhaust pipe is carried under the floor as usual, but it contains a tee the outlet of which projects upward, the pipe from it entering the heater. No outlet is required, but an air valve is provided to release the air which is trapped in the heater when the engine is started. A drip pipe is provided to let out the water of condensation, which, if allowed to flow back through the exhaust pipe, would interfere with the free circulation of the steam.

Exhaust Steam Turbines in England

By James A. Seager

The exhaust steam from the blast-furnace engines is superheated and used at atmospheric pressure in two turbo-generators which supply power to the surrounding districts.

An interesting development in the use of exhaust steam is to be found at the iron works of B. Samuelson & Co., of Middlesborough, England. Here the exhaust steam from the blast-furnace engines is collected and after being superheated is utilized in low-pressure turbo-generators which supply power to consumers as far north as the Tyne. The turbines are of the double-flow Parsons type with water-sealed glands arranged for operating with steam in the event of the water supply failing, and also for use when starting. A view of the turbines and generators is shown in Fig. 1. The governors are of the centrifugal type, driven direct through a worm gear and shaft from the turbine spindle, and control the valve which admits steam to the turbines. Two methods are provided for shutting down the turbines in case the speed should tend to increase above 10 per cent. over normal: one closes the governor valve and the other opens a large air connection to the condenser, thus destroying the vacuum without which the turbine cannot operate.

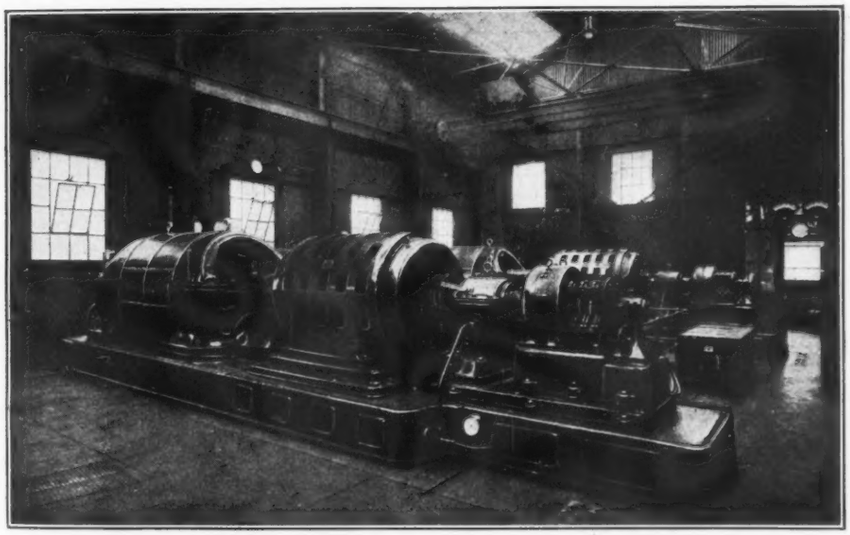


FIG. 1. GENERAL VIEW OF LOW-PRESSURE TURBINES

The surface condensers are placed directly beneath the turbines, Fig. 2 showing one end of a condenser together with the other auxiliaries. A striking feature is that there is no reciprocating apparatus in the whole installation, the dry-air pumps being of the Leblanc type and wet-vacuum pumps of the two-stage centrifugal type. Elaborate arrangements are made to keep the condenser and pumps free from mud or foreign matter which may be deposited from the circulating water drawn from the river.

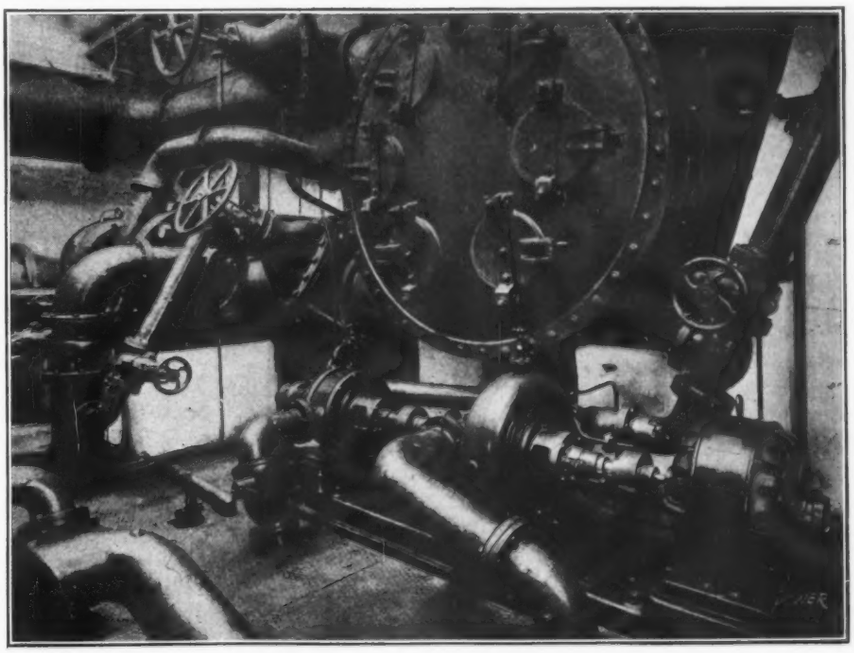


FIG. 2. CONDENSER AND PUMPS

On regular full-load service the condensers maintain a vacuum of 29 to 29½ inches with the barometer at 30 inches. In order to keep a continuous check on the steam consumption of the turbine the wet-vacuum pump delivers into a special measuring tank in the basement, from which the water is returned to be used over again.

The generators are of the three-phase, two-pole, revolving-field type, each capable of delivering 1250 kilowatts at a voltage of 6600. The guaranteed steam consumption of the unit was 27 pounds per kilowatt-hour with steam at atmospheric pressure superheated 50 degrees Fahrenheit and exhausting into a vacuum of 28.8 inches, referred to a 30-inch barometric pressure. These figures were easily attained on the recent official tests.

According to a note in the *Electrical Review*, the total available horsepower of the rivers of Canada is stated to be 25,682,907 on the basis of minimum flow development. Of this total only about 2 per cent.—516,887 horsepower—is now developed. The distribution of the water powers in the various provinces is as follows, the figures representing horsepower: Yukon, 470,000; British Columbia, 2,065,500; Alberta, 1,144,000; Saskatchewan, 500,000; Manitoba, 504,000; North-West Territories, 600,000; Ontario, 3,129,-168; Quebec, 17,075,939; New Brunswick, 150,000; Nova Scotia, 54,300.

Firing Boilers with Pulverized Coal

By W. S. Worth

A 300-horsepower boiler at the Henry Phipps plant in Pittsburg has been fitted with the Blake system of pulverizing coal, and during a period of two hundred days' operation has shown a high degree of economy. With this system the proper mixture of air and fuel is attained in the pulverizer, hence complete combustion takes place in the furnace. By using a set of nozzles the flame does not come in direct contact with the tubes.

About a year ago, a 300-horsepower boiler at the Henry Phipps power plant, Pittsburg, Penn., was fitted with a device for burning pulverized coal. This has been in operation about 200 days and has proved very satisfactory. Several tests and the records of the plant show that it has a high efficiency and that there is a considerable saving of fuel as compared with the other boilers of the same type fitted with mechanical stokers. The system is the invention of J. E. Blake, of New York, who spent 14 years in its development.

Principle of Operation

Referring to Figs. 1 and 2, the coal is crushed by an ordinary commercial crusher into small lumps about the size of cherries, and placed in the feed hopper of the pulverizer and blower, from which it is fed into the machine by an endless screw. The pulverizer is of the rotary type driven by a 12-horsepower motor. From Fig. 2 it will be seen that the coal, upon entering the chamber, is struck by the revolving paddles which break up the lumps into smaller fragments. The centrifugal force produced by the rotary motion given to the larger-sized lumps causes them to revolve near the surface of the cylinder and the baffles prevent them from passing to the second chamber. The air is drawn into the first chamber with the coal through passage *A* and also through the opening *B* around the shaft. After being given a whirling motion by the rotor, it passes to the second chamber and thence through the successive chambers, receiving in each a whirling motion before passing to the next. The smaller and lighter particles of coal in the first chamber are caught in the whirl of air and carried to the second chamber where the pulverization becomes finer, and so on throughout the successive stages until in the fourth chamber it is reduced to a fine powder suitable for burning. After entering the fan chamber, the mixture of coal dust and air receives an additional supply of air which is drawn into the fan chamber through the opening *C* and is discharged in an intimate mixture into two pipes conducting the mixture to the furnace. The air entering through openings *A*, *B* and *C* prevents the escape of coal dust.

Each pipe branches into a distributer, from which cylindrical nozzles discharge the mixture into the furnace, where it burns with a long flame closely resembling that of natural gas, except for the luminous particles heated to incandescence. The flame, which is directed downward at an angle of about 20 degrees to the vertical, impinges upon the bottom of the furnace, forming eddy currents, and the minute particles of coal dust burn completely while in suspension, the gases then passing over the heating surfaces of the boiler.

As the refractory lining of the furnace is heated to a high temperature, it assists in producing complete combustion. The furnace is of the reverberatory type, its action being the reverse of the ordinary industrial type.

Crusher

The crusher is of the ordinary vertical "coffee-mill" type and is belted to a one-horsepower motor. Low-grade slack coal is fed into the crusher by hand and is crushed into small lumps suitable for feeding into the pulverizer. The crushed coal is transported and charged into the pulverizer by hand. As the capacity of the crusher is greater than that of the pulverizer, it is not run continuously, the supply being crushed at suitable intervals.

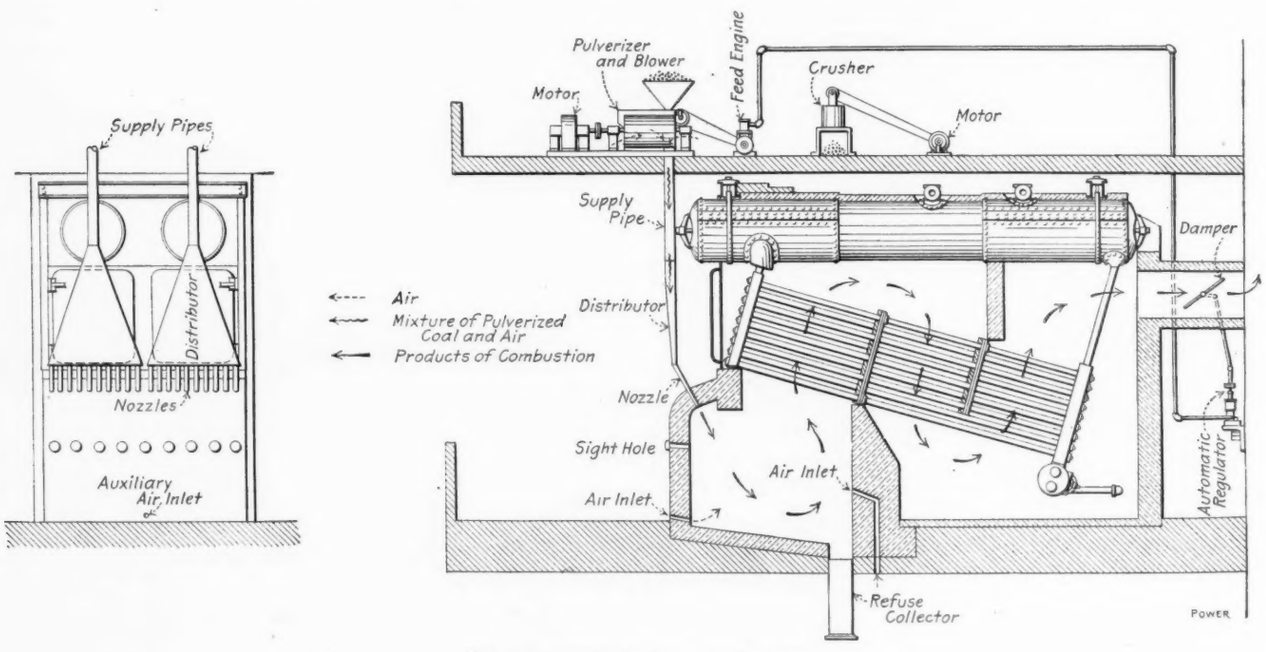


Fig. 1. System Applied to Boiler

Pulverizer and Blower

The pulverizer and blower are driven at a speed of 1200 revolutions per minute by a 12-horsepower motor direct connected to the rotor of the pulverizer. A small simple engine is belted to the feeding screw of the pulverizer. The casing of the present pulverizer and blower is made of boiler plate, but it is intended in the future to make this of cast iron divided horizontally on the center line as shown. The rotor consists of a steel shaft, carried in ring-lubricated bearings, to which are keyed the forged-steel rotors. To the arms of the rotor are bolted the paddles, which consist of hard tempered-steel plates.

The fineness to which the coal is pulverized depends upon the character of the coal and the required length of flame —the powder usually being from 80 to 120 mesh fine—and is regulated by the velocity of the air passing through with the coal; if the velocity is high, the powder will be coarse, and *vice versa*. The areas of the openings *B* and *C* can be adjusted to give the desired flow of air. The discharge pressure of the mixture is from ¼ to ½ inch of water.

It is planned to improve future machines of this kind by mounting the crusher on the pulverizer and operating it from the driving motor. A small model, about the size of a derby hat, in which these improvements were incorporated, was used successfully in firing a 12-horsepower boiler. In future designs, provision will also be made for varying the speed to suit the conditions.

Supply Pipes, Distributers and Nozzles

As shown in Fig. 1, the pulverizer discharges into a header from which the coal passes to the supply pipes, distributers and nozzles, all of which are made of No. 24-gage sheet iron. As no valves or cutouts are fitted, all nozzles are used regardless of the rate of combustion, there being eleven 2-inch cylindrical nozzles leading from each distributer· twenty-two in all.

Furnace

The furnace is lined with ordinary firebrick and has a refuse collector in the back, as shown in Fig. 1. It is about 5 feet long, 7 feet high (from the bottom to the boiler tubes) and 6 feet wide. The interior can be observed through peep holes in the front and one in a door at the side. A small supply of air, about 5 per cent. of the total supply, may be admitted to suit conditions through one opening in front and another in the back. The refuse collector extends through the floor and has an opening through which the refuse is run into a car on the floor below.

Automatic Regulator

The amount of coal fed, which is regulated by the speed of the engine driving the feed screw, is automatically controlled by a regulator in such a way that a decrease in boiler pressure increases the amount of coal fed, and *vice versa*. This regulator, which is located behind the boiler, controls the opening of the uptake damper and the amount of steam admitted to the engine which operates the feed. Referring to Fig. 3, the apparatus works as follows: Steam from the boiler is admitted through pipe *A* into the chamber below cylinder *B*, containing a diaphragm upon which the steam pressure acts. Lever *E* pivoted at *D* and carrying weight *E*, acts on the diaphragm at *C*, resisting the steam pressure beneath it. The movement of lever *E*, caused by the rise or fall in boiler pressure, opens or closes an electric circuit at contact *G*. When the pressure rises and the contact is made, the current energizes the solenoid *I* and causes its armature to rise, thereby raising the lever *J* which, in turn, revolves the stem *K* and the valve which it carries. This opening of the valve in cylinder *L* permits water under pressure to flow from pipe *M*, which is connected to the fire system, through the valve and pipe *N* into cylinder *O*. This cylinder contains a piston attached to the rod *P*, which rises when the pressure of the water is sufficient to overcome the weight on the piston. The rise of the piston rod, which is connected at *R* by levers to the uptake damper, causes the latter to close an amount corresponding to this movement. Should the piston rise sufficiently, the collar *S* will strike the arm *T*, lifting it together with rod *U* and rack *V*. The movement of rack *V* rotates the spur wheel *W*, which, in turn, moves the valve contained in *X*. The movement of this valve reduces the amount of steam flowing from the boiler through *Y*, *X* and *Z* to the engine operating the pulverizer feed, decreasing its speed, the quantity of coal fed and consequently the rate of combustion.

A fall in pressure permits lever *E* to drop; this breaks the circuit at *G* and shuts off the current from solenoid *I*, the armature of which descends and turns the valve in cylinder *L*. This shuts off the water entering through *M* and connects the cylinder, through pipe *N*, to the waste pipe *A'*, thus permitting water to flow out of the cylinder and allowing the piston and rod *P* to descend. The movement of *P* opens the uptake damper to which it is connected, and, if the movement be sufficient, collar *B'* will strike the arm *T* and cause a downward movement of rack *V* which rotates the valve in *X*, and admits more steam to the engine, in this way increasing the feed.

The boiler pressure can be adjusted as required by increasing or decreasing the weight *F*. The amplitude of the movement of lever *E* can be regulated by set screws *D'* and *E'*. The stroke of the piston and rod *P* can be adjusted by collar *S;* and the speed of the engine is adjusted with collars *S* and *B'*. or, if desired,

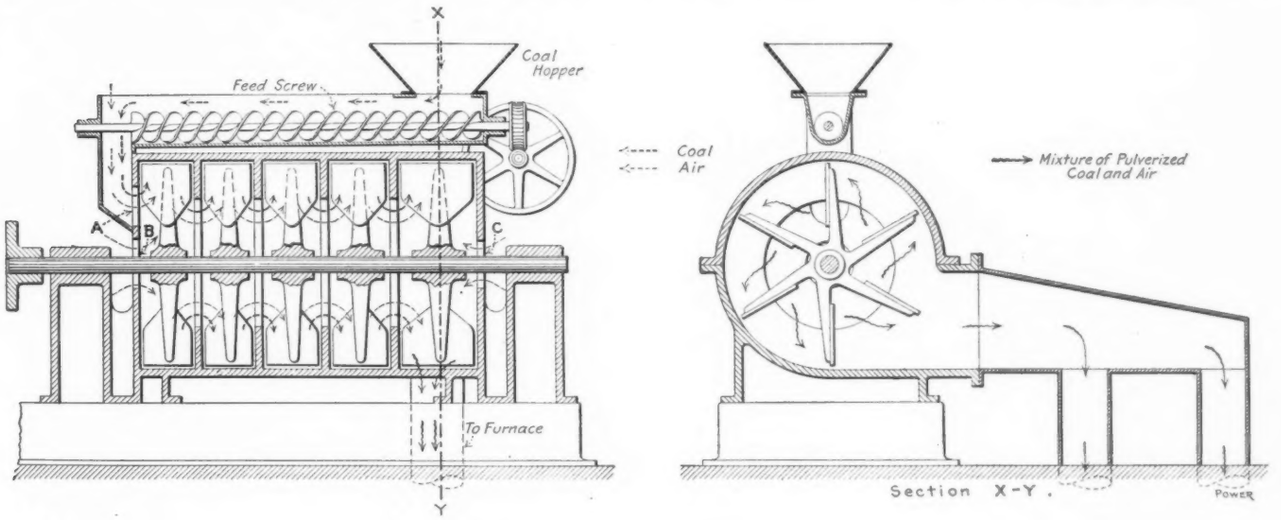


Fig. 2. Section through Pulverizer and Blower

arm *T* may be clamped to the rod by set screw *F'*.

The operation of the regulator is very satisfactory and there is no difficulty in regulating the pressure to give a variation of less than five pounds. Although it is used here to regulate only one boiler, it can be used for several.

TEST WITH PULVERIZED COAL AT THE HENRY PHIPPS POWER PLANT.

Duration of test, hours	6
Total weight of coal, fired, pounds	5,160
Total weight of water, pounds	56,160
Average temperature feed water, degrees Fahrenheit	186
Average steam pressure, pounds per square inch	162.3
Factor of evaporation	1.084
Water evaporated per pound of coal (actual, pounds)	10.88
Water evaporated per pound from and at 212 degrees, pounds	11.725
Boiler efficiency (coal containing 14,350 B.t.u.), per cent	78.93
Horsepower of boiler	294.6
Builder's rating	300
Temperature of escaping gases, degrees Fahrenheit	386
Cost of coal, 2.58 tons @ $1.315 per ton	$3.392
Cost of coal per pound	0.0006575
Pounds of coal per boiler horsepower per hour	2.92
Cost of coal per boiler horsepower, cents	0.19199

Economy

The foregoing table shows the results of a test made by the superintending engineer of the plant. This test agrees very closely with other tests which have been made, none of which show a boiler efficiency less than 77 per cent. In making these tests, the evaporation was determined by measuring the amount of water fed to the boiler.

It should be noted that the temperature of the escaping gases is very low. Under the usual working conditions it does not exceed 400 degrees Fahrenheit, and after uniform conditions have been attained it does not vary over 25 degrees. The power-house records show that this boiler is much more economical in coal consumption than the other boilers and it is claimed that the saving in fuel exceeds 11 per cent. In addition to the saving in the quantity of fuel, a considerable saving in the cost of operation is effected because of the following factors: Cheaper coal is used—the coal for the boiler using pulverized coal costs 4 cents per bushel, whereas the coal for the other boilers costs 5 cents; fewer repairs are required; and, in addition to these, may be added for future plants, less cost for attendance and less wear and tear on the boiler, due to the uniform temperature.

Operation and Performance

To get up steam, a wood fire is first built in the furnace and the pulverizer is started supplying air and fuel, moderately at first and finally working up to the normal rate of combustion. There is no difficulty in starting as the mixture ignites readily and burns with a steady flame. The combustion is more perfect, however, when the flame is not cooled by impinging upon the cold surfaces of the furnace. It requires about three hours to heat the furnace to its normal running heat, after which the high temperature of the furnace assists in producing complete combustion. The time required to raise steam depends upon the rate of combustion. Ordinarily steam is raised in about an hour, but this time could be reduced to half an hour if desired.

When normal running conditions have been established, the combustion is completed before the gases pass to the tubes. All parts of the furnace are clearly visible as there is no smoke and the flame is unusually transparent. Moreover, there is practically no noise from the furnace.

The refuse is a fine light powder, resembling fine sand, and containing no unconsumed carbon. It is neither corrosive nor adhesive and can be easily handled with compressed air. This dust collects on the tops of the horizontal tubes but does not adhere to the remainder of the tube surfaces. When the apex of the pile of dust on a tube reaches a certain hight, the powder begins to slide off, and, when once started, nearly all runs off. In view of this it is not considered worth while to clean the tops of the tubes; hence tube cleaning is eliminated from the routine.

In many cases where pulverized fuel is used a large percentage of the refuse passes through the boiler and passes up the stack. With this system, however, apparently none of the refuse passes out through the stack as no traces of it have been found on the roof of the power house nor on those of adjacent buildings. As previously mentioned, the refuse from the furnace is deposited in a collector. There is a comparatively small quantity of refuse and ordinarily the collector is emptied every three or four days. After eight days of operation, when using 750 pounds of low-grade Pittsburg slack per hour, only about three-quarters of a ton of refuse was removed from the collector.

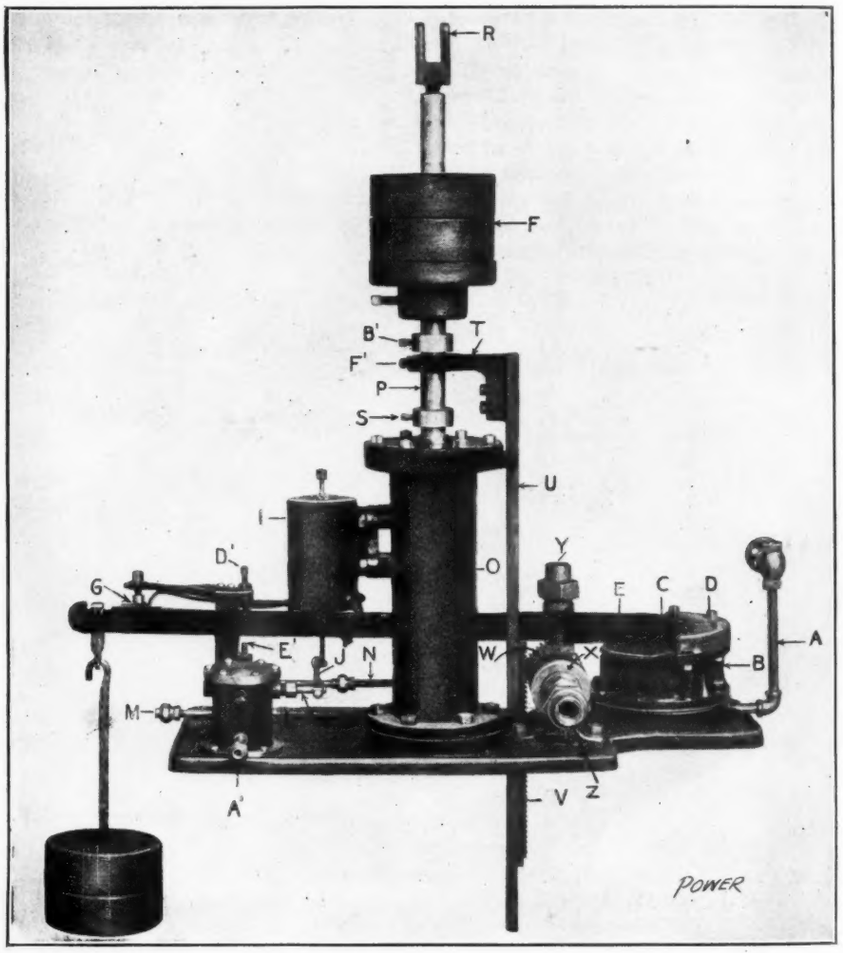


Fig. 3. Automatic Regulator

The tubes immediately above the furnace become coated with a sulphurous deposit which does not appear on the other tubes. This deposit does not exceed ⅛ inch thick and it soon cracks and falls off. The refuse cakes on the firebrick lining of the furnace to a thickness of less than an inch; but this can be easily scraped off. In fact, it is an advantage in that it protects the firebrick and prolongs the life of the furnace.

No difficulties have been experienced by the tubes becoming burned, which is undoubtedly due to the fact that the

flame does not impinge on the tubes, and also that combustion is completed before the gases come in contact with the tubes.

Experience has demonstrated that even a large percentage of moisture in the coal has no appreciable effect on the pulverization and burning. The moisture is dried out by the mechanical action of the air during pulverization so that the dust is quite dry and the particles do not adhere. Only two kinds of low-grade coal have been used, but there is little doubt that high-grade coals can be used successfully.

The fineness of pulverization depends upon the quality of the coal, a coal which burns with a long flame being pulverized finer than one having a short flame. Hence, the length of flame can be regulated by adjusting the pulverizer. The rate of combustion can be regulated through a wide range and can be reduced until the heat is just sufficient to keep the furnace hot. The proportion of air to coal is kept constant for all rates of combustion, the quantity of mixture being regulated.

With this apparatus, one man is required to operate the crusher and the pulverizer, and on the boiler floor another attends several boilers. With the apparatus as improved, the supply of fuel will be handled entirely by machinery and the regulation will be automatic, thus considerably reducing the attendance. The cost for repairs has been less than five dollars for 200 days' operation, and it is estimated that the paddles will last at least a year with almost continuous operation. The cost of pulverizing a ton of the coal used in the test herein cited, was 9.2 cents; and it is estimated that the power required for driving the improved pulverizer will be less than 0.04 horsepower per boiler horsepower.

The chief thermal gain in the use of pulverized coal is due to the high degree of perfection in combustion, coal in the powdered state being the best form in which to obtain perfect chemical combination with the oxygen of the air. The rapid combination of the air and coal, however, produces a high temperature, which, in many cases, has been so excessive as to cause failure. The chief difficulties that have been encountered from this source are the fusing of the firebrick lining of the furnace and the fusing of the refuse, forming a slag. To remedy the former, a special firebrick, made from carborundum dust, has been used successfully, but it cannot be said that this disposes entirely and satisfactorily of the difficulties from high temperatures. In the system under discussion, this problem has been solved in a satisfactory way, by regulating the intensity of combustion and in consequence the temperature of the furnace.

Analyses of the flue gases from boilers using pulverized coal show exceptionally good results, there usually being not more than 10 to 15 per cent. excess of air, and no CO, and in most cases the CO_2 is from 13 to 15 per cent.

Pulverized coal is particularly suited to automatic regulation and it is unusually sensitive to control, so that the demands of fluctuating power are easily met. Perhaps the best method is to regulate the mixture automatically so that the correct proportions of air and coal required for complete combustion will be maintained regardless of the quantity supplied. It is obvious that provision should be made for adjusting the air and coal independently to obtain the correct proportions for the particular fuel being used. As the pulverizer described herein was designed for working under practically constant conditions, no provision was made for the automatic regulation of the air in conjunction with that of the coal, but, for future work, provision will be made for the automatic regulation of the air and coal together so that the correct proportions will be maintained under variable conditions.

Either hard or soft coal can be burned satisfactorily in the pulverized state. Coal with a fair percentage of volatile matter seems to be better suited for this purpose as it is more easily pulverized and burns better. Moisture up to 15 per cent. does not interfere with the pulverizing and burning, and in this system the air that is present during the pulverizing and mixing dries the coal sufficiently to prevent the particles from adhering. One of the principal advantages of pulverizing is that coal with a high percentage of ash can be burned efficiently; poor grades of coal having been burned with about the same thermal efficiency as that obtained from high-grade coal. Slack coal requires less power for pulverizing, and is therefore the more desirable.

Pulverized coal is safe providing it is used correctly, but it is hard to convince some that it is not extremely dangerous. Many accidents in the use of pulverized coal have been recorded, but it is safe to say that they were caused by not observing the proper precautions, both in design and operation. A number of accidents have been caused by spontaneous combustion and others by the ignition of a mixture of air and coal dust. Although it is claimed that pulverized coal can be stored with safety, it is obviously better to entirely eliminate this source of danger by not storing it at all. With properly designed machinery, having a short and direct discharge to the furnace, there is no difficulty in preventing the escape of the dust.

Boilers using pulverized coal are not subjected to sudden changes of temperature, such as are hand-fired boilers, hence the uniformity of temperature is a particular advantage.

In marine work mechanical stokers have not been successful, and in this field pulverized coal has the greatest advantages. On account of the limited space on a ship, it may not be possible to prevent the escape of the refuse in the form of dust, but, it is doubtful if this will be very objectionable.

For naval work in particular and marine work in general, its advantages are as follows: Greater economy in fuel can be attained. Maximum power can be maintained as long as the coal can be supplied. There are no fires to be cleaned and the fire-room force can be reduced. There is no smoke and the pulverizers and pneumatic ejectors would take the place of blowers, and ash-handling machinery, and it would not be necessary to carry large supplies of spare grate bars, firebrick, etc. The refuse does not cause corrosion and the fire-room bilges would remain in good condition, which also applies to the heating surfaces of the boilers. On account of the uniform temperature, there would be less wear and tear on the boilers. The fire rooms would not be under pressure and could be left open. Low-grade coals could be used.

It cannot be said that firing boilers with pulverized coal has been an unqualified success. In fact, nearly all attempts have failed in one respect or another, and it is the general opinion among engineers that, although it is possible to burn pulverized coal, its use for firing boilers is neither practical nor commercial. This doubt may be dispelled to some extent by the fact that this plant is running practically and is a success commercially. It is expected that further tests will be made in the near future and if these substantiate those already made, there will be no question as to the success of this system of firing boilers, in both land and marine practice.

When cutting pipe threads in a lathe it is sometimes difficult to get the exact diameter necessary. When a mistake is made and the threads on a 6-inch pipe are cut a trifle too small, so that it screws right up to the shoulder, then it remains for the workman to get out of the trouble the best way he can. A very good way is to use wire cloth of the brass variety, about 60 or 80 meshes to the inch, similar to that used by the farmer for straining his milk. Wrap a bit of wire cloth around the pipe, daub it with litharge or red lead and screw the pipe home with the wire cloth in the joint. This joint will never leak or come loose.

A plan is on foot to use the power at Great Falls on the Potomac river for a hydroelectric plant to generate current for consumption in the District of Columbia. At present 4458 horsepower is required, but the power available at Great Falls, even at low water, is considerably over 6000 horsepower, and by using a storage reservoir above the falls it could be increased to about 8650 horsepower.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Jones; Trouble Killer

FIRST TALK ABOUT POWER FACTOR

"Well, well," exclaimed Harvey, "if that ain't Jones cuttin' corners through the back lot I'll eat hay till hell free—"

"You'd oughter eat it, anyhow," broke in the engineer; "I would, if I'd made such a jackass o' myself as you did last time Jones was here."

Further compliments were prevented by the unceremonious entrance, through the spur-track door, of a rotund person wearing a Fedora hat tilted on the left side of his head, a wide opening in his face just below his nose and a nondescript suit of clothes. Nobody ever knew or cared what kind of clothes Jones wore; his hat and his grin caught your attention first and your eyes never got below the grin.

A ROTUND PERSON WEARING A FEDORA HAT AND A LARGE OPENING UNDER HIS NOSE

"Hello, boys," sang out Jones cheerily; "what do you know about this for winter weather?"

"Nothin' the matter with the weather," replied the engineer, "except its power factor 's a little low."

"Joke," said Harvey. "No wonder Jones is in a sweat. Say, old man, if you don't hurry and wipe your face, you'll drown."

"Surest thing you know," agreed Jones, taking off his coat and mopping his face and neck with a two-foot bandanna. "But, talking about power factor reminds me that I promised to reel out a yard or so of dope on that subject the next time I got around. How about it, Jim?"

"You sure did," said the engineer, "and the primary class is ready and willin' to take his medicine."

"Well," said Jones, shedding his vest, collar and necktie and turning up his sleeves, "let's see where we'd better begin."

"Hadn't I better run over to the house and get you a suit o' pajamas?" asked Harvey, with mock courtesy.

"S'pose," began Jones, paying no attention to Harvey's effort at bantering, "s'pose your voltmeter showed 115 and your ammeter 30 and your indicating wattmeter 120 kilowatts. You know what the power factor would be, don't you?"

"Yes; because you told me how to figure it," said the engineer, "but I don't understand why."

"Never mind that for the present," said Jones. "Just to get a good start at the beginning, figure that power factor."

"Cinch," broke in Harvey; "lemme do it," and he jotted down these figures on a scratch pad:

115 volts
30 amperes
3450

"A hundred and fifteen multiplied by thirty is thirty-four hundred and fifty—thirty-four hun— oh, you're stringin' us."

"No he ain't," exclaimed the engineer excitedly, "you've forgot that when the voltmeter reads a hundred and fifteen the voltage in the primary line where the ammeter is connected is twenty-three hundred. Here—" and he hastily scrawled Fig. 1. "The voltmeter takes current through a transformer and shows the secondary voltage but the ammeter shows the primary current."

"Right you are," said Jones, beaming like a polished tomato. "The primary class is making headway. Finish the job."

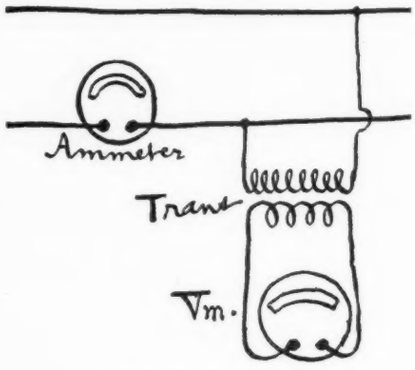


FIG. 1. THE ENGINEER'S SKETCH

"When the voltmeter voltage is a hundred and fifteen the line voltage is twenty-three hundred because the transformer ratio is twenty. "Let's see—" and he began figuring as follows:

2300 volts
30 amperes
69000 app. watts
69000)120000(

"Thirty times twenty-three hundred is sixty-nine thousand and sixty-nine thousand goes into a hundred and twenty thousand—hold on; that would make the power factor nearly two," he exclaimed.

"Come to," advised Jones, relaxing his grin a couple of points. "You know better than that."

"Thirty times twenty-three—"

"Cut it out," said Jones. "Your arithmetic's all right; no use to keep on repeating that like the man who went crazy saying 'twice two is four, twice three is five.' It's your horse sense that's off—not your figures."

The engineer scratched his head and Harvey stared at the figures with a bewildered expression.

"Oh, stuff!" ejaculated Jones. "You ain't thinking; you're just rattled. Where is your ammeter connected in regularly?"

"In the A phase of the line," replied the engineer.

"Where is your wattmeter connected in?"

"In both pha— oh, damn! The ammeter measures the current in one phase and the wattmeter measures the power in both phases, of course."

"Quite so," agreed Jones; "proceed."

Harvey softly whistled "Every little movement has a meaning all its own," and the engineer chased him into the producer room.

"But you didn't say anything about the current in the other phase," protested the engineer, returning to his seat on a transformer case.

"And you didn't use your brains, so you fell for it," rejoined Jones, increasing his grin to $3\frac{13}{16}$ inches. "Now, start all over again and do it right."

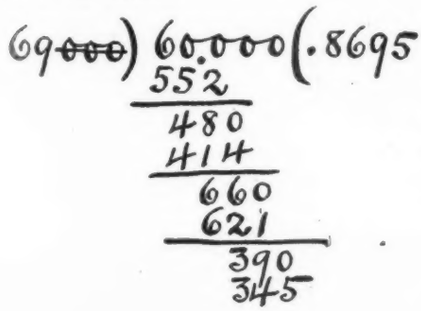
"Or quit," amended Harvey, from a safe distance.

"Better paste that editorial in the middle o' your lookin' glass," suggested the engineer, taking a dig at Harvey's only serious weakness—personal vanity.

"Well," he resumed, "if the two phases are balanced, each one'll carry half the power, so that if the total power is a hundred and twenty kilowatts the power in each phase'll be sixty kilowatts or sixty thousand watts."

"Right," said Jones.

"Then, if the apparent watts in each phase are sixty-nine thousand and the actual watts are sixty thousand, the power factor'll be—" and he made the following division:



"point eight, six, nine, five—practically point eighty-seven.'

"All right," said Jones, "but what does point eighty-seven mean?"

"Eighty-seven hundredths."

"Yes; but is that what you'd call the power factor?"

"Oh; eighty-seven per cent."

"Correct. Now you said thirty times twenty-three hundred was sixty-nine thousand, but you didn't say sixty-nine thousand what. It isn't watts, is it?"

"No; apparent watts."

"Yes; that's true enough, but there's a better name for it."

The engineer shook his head.

"Search me."

"Volts multiplied by amperes make what?"

"Appar—"

"You said that before; try something else. Wits gone wool-gathering again?" as the engineer sat staring at him.

"N-o-o, but—"

"Oh, come now; wake up. Volts multiplied by amperes—volts times amperes—volts, amperes—"

"Volt-amperes," said the engineer meekly; "please kick me."

"I'll leave that to your conscience," said Jones. "You see, apparent watts is a good enough name because volts multiplied by amperes would be watts if there weren't any power factor to bother with. But volt-amperes is more descriptive, because it is common custom in engineering to hitch two things together with a hyphen when you are talking about their product and there isn't any name for it. There's feet multiplied by pounds—foot-pounds; kilowatts multiplied by hours—kilowatt-hours, and so on."

"But why do volts multiplied by amperes make volt-amperes in alternating-current work and not with direct current?"

"I never said any such thing," replied Jones; "you've got it twisted. Volts times amperes are volt-amperes every time and in any system, but volt-amperes are the same as watts in a direct-current system, while they are not the same with alternating current unless the circuit is entirely free from inductance, which is not usually the case."

"Then, what's the difference between watts and alternating volt-amperes?" asked the engineer.

Jones manifested signs of impatience.

"How do you figure the power factor of a circuit or a system?" he asked.

"Divide the watts by the appar— by the volt-amperes," said the engineer.

"Then, for heaven's sake why can't you see the relation between watts and volt-amperes?" asked Jones. "Suppose you knew the power factor and the volt-amperes, how would you figure out the real watts?"

The engineer figured on his pad awhile.

"Multiply the volt-amperes by the power factor?" he suggested, hesitatingly.

"Of course. Then, why do you ask me what the difference is between watts and volt-amperes?"

"Well, I didn't mean it exactly that way," said the engineer, a little abashed. "I know how watts and volt-amperes and power factor are tied together in arithmetic, but—"

"Let's make sure of that much," advised Jones. "You persisted in saying 'apparent watts' awhile ago when I wanted you to say 'volt-amperes.' Now go back to your apparent watts. Apparent watts are apparent power, and you just said that multiplying volt-amperes or apparent watts by the power factor gave you the real watts, didn't you?"

"Yes; but—"

"Don't butt in. If your apparent power were fifty thousand volt-amperes and your power factor eighty per cent., what would the real power be?"

"Forty thousand watts," said the engineer, after a moment of hasty scribbling.

"Right. Now, don't you see that the power factor is simply the number by which the apparent power is multiplied to get at the real power?"

"Ye-es."

"No you don't, but listen. With fifty thousand volt-amperes and eighty per cent. power factor, the real watts would be forty thousand, you said."

"Yes."

"Then eighty per cent. of your apparent power is *real* power, isn't it?"

"Oh, I see what you are driving at. Sure; I understand that if the power factor is eighty per cent. then eighty per cent. of the apparent power is real power, and if the power factor is sixty per cent., then sixty per cent. of the volt-amperes are real power. But I don't understand why *all* of the volt-amperes ain't real power, like direct current. Why *is* there any power factor?"

"That's what I'm coming to," said Jones, "but we've wasted so much time on the arithmetic it's time to eat. I'll tell you the balance after we feed." And he made a dive for the wash sink just in time to beat Harvey to it.

Old man Dodder doubled the size of his dry kiln at the planing mill and found that the fan was too small and would not deliver enough hot air. His nephew Bill was back from college and tackled the job. He figured all over the side of the shed and told his uncle that to deliver twice the amount of air he would need a 125-horsepower engine to run the fan, as the rules showed one must cube the horsepower required to run the fan with the old kiln. The old man scratched his head and sent for Jim, the engineer, to help him out. Jim grinned and said that all they would need was another 5-horsepower fan, as the two would deliver double the amount of air.

Dodder reckons Bill had better shovel shavings and help Jim a while.

The Melville-Macalpine Gear for Direct-current Turbine Generators

By Geo. W. Malcolm

In a paper read some time ago before the Engineers' Society of Pennsylvania, J. A. MacMurchie advocated the use of the now widely known Melville-Macalpine turbine gear to drive direct-current generators, instead of coupling them directly to the turbine. Mr. MacMurchie cited, as warranting this practice, the fact that it would permit the use of a generator running at its most economical speed instead of one driven at such a high rate as to entail excessive losses by windage and friction.

A chart was presented with the paper which indicated the following comparisons, based on steam at 150 pounds pressure and a condenser vacuum of 28 inches:

	Pounds of Steam per Kilowatt-Hour.	
Size of unit	1000 kw.	2000 kw.
Direct-driven, direct-current generator	20.6	20.2
Direct-driven alternator and rotary converter	20	19.5
Gear-driven direct-current generator	19.3	19

The combination of turbine-driven alternator and rotary converter was included in the comparison in order to cover all practical methods of obtaining direct-current distribution from a turbine-driven generating plant. It is exemplified by railway practice throughout this country, rotary converter substations being used to change the high-tension alternating current sent out from the generating station into direct current of the proper voltage for the railway. Such a system, however, can scarcely be compared with the turbine-driven direct-current dynamo because the conditions to which the two are rationally applicable are widely dissimilar.

The logical comparison is between the direct-driven and the gear-driven direct-current generators.

According to Mr. MacMurchie's chart, the gear-drive outfit would require 19,300 pounds of steam per hour and the direct-coupled outfit 20,600 pounds, in the 1000-kilowatt size. The heat energy theoretically available by expanding a pound of steam under the conditions stated is 339 B.t.u., if the steam be superheated 100 degrees initially. On this basis the overall heat efficiency of the direct-coupled unit would be 48.8 per cent. and that of the geared unit 52.2 per cent. The following tabulation gives a comparison of the two generators for four values of turbine efficiency and on the assumption that the Macalpine gear has 97 per cent. efficiency:

Turbine Efficiency.	Corresponding Generator Efficiency.		
	Direct driven Generator.	Gear and Generator.	Geared Generator.
54%	90.4	96.7	99.7
56%	87.2	93.2	96.1
58%	84.2	90.0	92.8
60%	81.4	87.0	89.7

Obviously, the combination indicated in the first line is impossible because the generator could not have 99.7 per cent. efficiency. The most plausible combination would seem to be the one in the second line, although 96 per cent. is a little high for the geared generator and 87.2 is unnecessarily low for the direct-driven generator.

It is difficult to imagine such an increase in generator efficiency as the 9 per cent. shown practically throughout the range here considered, due merely to the difference between the speeds of the coupled and geared generators. The windage, iron losses and friction would be increased by the higher speed, but this would be neutralized to a very great extent by the decrease in purely electrical losses. Moreover, the increased fixed charges on the cost of the geared outfit would require a very healthy decrease in fuel consumption to offset it.

Steam Heated Flume Racks for Hydraulic Plants

Operators of power plants in which the generators are driven by waterwheels do not need to be told anything about the difficulties in keeping head-gate racks clear of frazil ice in latitudes where ice forms. An interesting method of eliminating such ice troubles was proposed recently by John Murphy. In a paper read before the Ottawa branch of the Canadian Society of Civil Engineers. Mr. Murphy's plan is to equip the head-gate racks with pipe manifolds and to pass steam through the manifolds. The warm pipes, it is stated, prevent the accumulation of frazil ice at the racks by melting the ice, which is formed in very small particles. Mr. Murphy said that a ton of coal per day of twenty-four hours would make sufficient steam to keep the gates of a 3000-horsepower station free from ice. This, obviously, would be much cheaper than allowing the gate racks to freeze up and driving the generators by auxiliary steam equipment.

When cutting bar steel or rails by the usual method of nicking with a cold chisel, if the nicked part of the material is cooled by laying on a piece of ice, it will be rendered temporarily brittle and fracture easily when struck a blow with a sledge.

LETTERS

Erratic Belt Behavior

A 12-inch belt driving a dynamo persistently runs over one or the other edge of the dynamo pulley when shutting down and starting up, but when pulling the load it runs true with the center line of the pulley. The dynamo pulley is 23 inches in diameter and 16 inches wide; the engine pulley is 7 feet in diameter and 16 inches wide, and the pulleys are 30 feet apart, center to center. Can any reader of Power explain why the belt will not stay in place when starting up and shutting down?

W. S. Hull.

Sheldon, Ill.

A Cranky Induction Motor

Some time ago I was called upon to repair an induction motor that would not carry the load. It was a 220-volt, two-phase machine with a squirrel-cage rotor, rated at 15 horsepower. It had been running a rock crusher about two years and had probably averaged four months' continuous running for each year. It had been out of use about a month when I saw it.

Examination showed that the airgap was not uniform all the way around. The insulation of the stator winding appeared to be in perfect condition and everything else seemed to be all right except the airgap. I equalized this by shimming under the bearings with paper, tested each phase with two 110-volt lamps in series at the motor terminals and also tested them with a magneto; tested for grounds, and finally rewired the autotransformer, thinking perhaps the trouble might be in that, but it is still undiscovered.

The motor will not start until the lever on the autotransformer is in the running notch, but immediately starts on full-line voltage, if started in one direction; if the direction of rotation is reversed, it starts nicely on the second starting point. It apparently takes an excessive current while starting and running in either direction, as it visibly dims the two 110-volt lamps in series on the line.

The motor is supplied from two transformers which do not supply anything else, and each one is of ample capacity to carry one-half the full load. The owner said it had carried the load continuously on a certain Friday and on the following morning had started all right but refused to take any load.

Any suggestions as to what might be the matter with it will be greatly appreciated by me.

H. Blue.

Kirksville, Mo.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Long Stroke and Short Stroke Engines

By Paul C. Percy

It is a matter of common observation in engineering circles that the daily papers usually make themselves ridiculous when they discuss technical matters. This is natural, though amusing. When a professedly engineering journal makes foolish statements, however, it is neither excusable nor amusing.

The immediate provocation for these remarks is an article on the long-stroke gasolene engine, which appeared in a recent issue of a gas-power periodical. The following are the worst specimens of misinformation contained in the article:

1. The long-stroke engine does its work more easily than the short-stroke one for the same reason that a big man walks at four or five miles an hour with an easy swinging stride, while a small man has to "exert himself tremendously" to keep up with the other.

2. In a long-stroke motor the question of leverage enters. The long-stroke motor can turn its crank shaft with less effort than the short-stroke engine because of the longer crank throw, giving greater leverage over the load.

3. The gases in a long-stroke motor, "starting at a higher initial pressure on account of the increased compression possible with the longer stroke, are worked down to a much lower final pressure before they are exhausted into the atmosphere."

4. The gases in a long-stroke engine are expanded to a greater number of clearance volumes than in a short-stroke engine, and the long-stroke engine allows a much greater compression; hence the long-stroke engine is more economical.

5. The exhaust gases of the long-stroke engine are much cooler than those of the short-stroke engine because of the greater expansion.

All of the foregoing statements are absolutely untrue. The long-stroke engine is more desirable than the short-stroke engine in the following respects only:

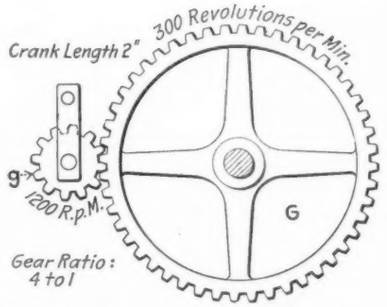


Fig. 1. Gearing of the Short-stroke Engine

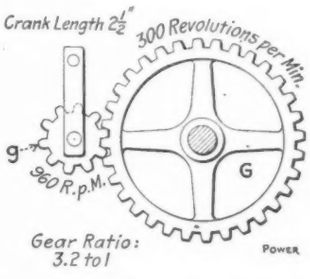


Fig. 2. Gearing of the Long-stroke Engine

The short-stroke engine must make a greater number of revolutions per minute than the long-stroke engine to run at the same piston speed. Therefore, the wear and tear on the reciprocating parts, crank pin and crank-shaft bearings is greater, for equal piston speeds.

The piston speed of the long-stroke engine can be made higher than in the short-stroke engine and the number of revolutions per minute kept the same or even be made less; if the latter is done, a smaller piston diameter is required, and this gives a correspondingly smaller total pressure on the connecting-rod boxes and main bearings.

These points are presented clearly and concisely by the numerical comparison in Table 1. These figures are, of course, appropriate for automobile and motor-boat practice. For the ordinary stationary engine the comparison in Table 2 is more suitable.

Both of these tables show clearly that for equal horsepower a long-stroke engine can be made to run at fewer revolutions per minute with the same total piston pressure and piston speed, or with less piston pressure and higher piston speed.

Now, let us see about the question of

TABLE 1.

Engines.	Short Stroke, A	Long Stroke. B	Long Stroke. C
Piston diameter, inches	4	4	3.77
Piston area, sq.in.	12.57	12.57	11.17
M.E.P. per square inch	70	70	70
Total mean pressure	879.67	879.67	781.9
Stroke, inches	4	5	5
Revolutions per minute	1200	960	1080
Piston speed	800	800	900
Indicated horsepower	5½	5½	5½

TABLE 2

Engines.	Short Stroke. D	Long Stroke. E
Piston diameter, inches	10	9½+
Piston area, sq.in	78.54	65 45
M.E.P. per sq.in.	80	80
Total mean pressure	6283.2	5326
Stroke, inches	12	16
Revolutions per minute	250	225
Piston speed	500	600
Indicated horsepower	23.8	23.8

"leverage." In the examples cited in the article I am criticizing, the piston speed was the same for both short-stroke and long-stroke engines, as in the cases *A* and *B*, of the first table. Figs. 1 and 2 illustrate this case diagrammatically. In the one case a 2-inch crank (4-inch stroke) revolves 1200 times a minute and is geared to the load shaft at 4 to 1; that is, the gear *g* on the crank shaft is one-fourth as large as the gear *G* on the load shaft and therefore turns four times as fast; consequently, the load shaft runs at 300 revolutions per minute. Putting it the other way, while the load shaft is making one revolution the crank makes four.

The diameter of the circle followed by the crank pin is 4 inches; in four revolutions, therefore, the crank pin travels

$$3.1416 \times 4 \times 4 = 50.266$$

inches.

In the other case, Fig. 2, with the same horsepower and the same piston speed the 4x5-inch engine runs at 960 revolutions per minute, and in order to keep the speed of the load shaft at 300 revolutions per minute the gear ratio must be 3.2 to 1 instead of 4 to 1 because the crank-shaft speed is only $\frac{3.2}{4.0}$ of what it was before. Therefore, when the load shaft

makes one revolution the crank makes only 3.2 revolutions. The crank being 2½ inches long, the crank circle is 5 inches in diameter and the crank pin travels

$$3.1416 \times 5 = 15.708$$

inches per revolution. In making 3.2 revolutions, therefore (while the load shaft makes one), the pin will travel

$$15.708 \times 3.2 = 50.266$$

inches, or exactly the same distance the 2-inch crank pin travels during one revolution of the load shaft. Where is the increased leverage over the load?

"But," probably says the author of the criticized article, "I meant the case where the piston speed is increased."

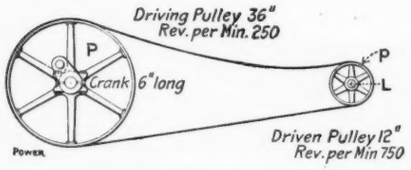
All right; let's see how that pans out, using the figures for engines *D* and *E*, in the second table. Figs. 3 and 4 illustrate the comparison. Suppose the load shaft *L* must run at 750 revolutions per minute, no matter what the speed of the engine may be. That is a practical condition where the machinery driven by the engine runs at constant speed. Also suppose, in order to keep the belt velocity the same, that the pulley *p* is 12 inches in diameter in both cases and that the diameter of the gas-engine pulley is chosen so as to get the desired speed at the load shaft *L*.

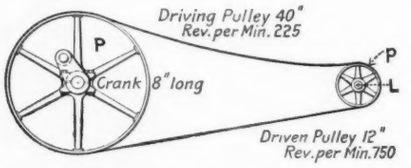
In Fig. 3 the short-stroke engine *D* (see data in Table 2) is represented as driving the load. As its speed is 250 revolutions per minute, its pulley must be 36 inches in diameter because the speed ratio is

$$\frac{750}{250} = 3$$

and the pulley ratio must be the same. The orbit of the crank pin is 12 inches in diameter, so that the pin travels

$$3.1416 \times 12 = 37.7$$





FIGS. 3 AND 4. COMPARISON WITH DIFFERENT PISTON SPEEDS

inches when the crank shaft makes one revolution. During this time the load shaft *L* makes three revolutions; consequently, the crank pin travels

$$\frac{37.7}{3} = 12.5667$$

inches for each revolution of the *load* shaft.

Now refer to Fig. 4, where the long-stroke engine *E* is represented as driving the same load. On account of the lower speed of the engine its pulley must be larger; the speed ratio is

$$\frac{750}{225} = 3\frac{1}{3}$$

and the engine pulley is therefore

$$3\frac{1}{3} \times 12 = 40$$

inches in diameter.

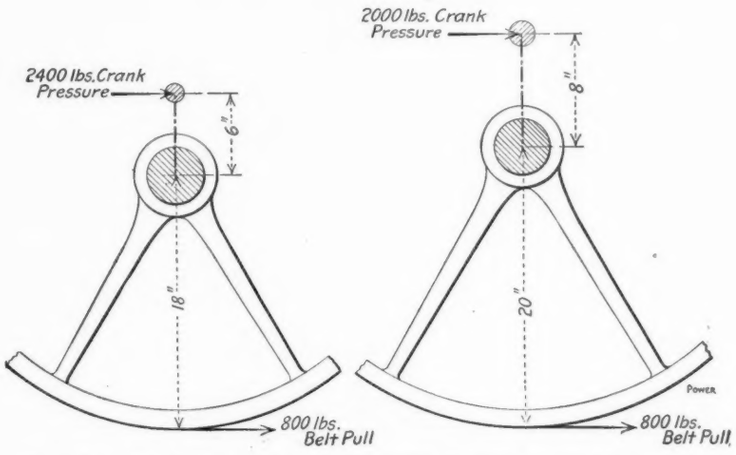
The crank-pin circle is 16 inches in diameter; therefore, in one revolution the crank pin travels

$$3.1416 \times 16 = 50.266$$

inches, and for each revolution of the *load* shaft it travels

$$50.266 \div 3\frac{1}{3} = 15.08$$

inches, as compared with 12.57 inches for the 6-inch crank.



FIGS. 5 AND 6. BALANCE BETWEEN CRANK PRESSURE AND BELT PULL

"Aha," says the other man, "didn't I say the long-stroke engine had more leverage over the load?"

You did, you did; but hold up a moment. What good is the extra leverage if the force applied to it is less? Refer to the data in Table 2 and you will see that the total piston pressure of the engine *D* is 6283.2 pounds, whereas the engine *E* can exert only 5236 pounds. Of course, these are not the average pressures on the crank pins, but the proportionate pressures are in the same ratio. That is, if the average pressure on the crank pin, throughout one revolution, were 2400 pounds for the short-stroke engine *D*, it would be only 2000 pounds for the long-stroke engine *E*, both developing the same horsepower.

Now, the previous calculations showed that the pin of the 6-inch crank travels 12.5667 inches in the same length of time that the pin of the 8-inch crank travels 15.08 inches. Suppose the average pressure on the short crank is 2400 pounds and that on the long crank 2000 pounds; evidently, it is not any harder for the pressure of 2400 pounds to push the load 12.5667 inches than for the pressure of 2000 pounds to push it 15.08 inches in the same length of time, because

$$2400 \times 12.5667 = 30{,}160$$

and

$$2000 \times 15.08 = 30{,}160.$$

Look at it in another way. As the load pulley *p* is of the same diameter in both cases, the belt velocity is the same and the belt pull the same in both cases. Suppose the belt pull to be 800 pounds and the engine to be frictionless. Then 2400 pounds pressure at the pin of the 6-inch crank will balance the 800 pounds belt pull at the rim of the engine pulley, because the radius of the pulley is three times the length of the crank; see Fig. 5.

Now, consider the long-stroke engine *E*. The crank-pin pressure is 2000 pounds; crank length, 8 inches; pulley radius, 20 inches, and belt pull, 800 pounds, as represented in Fig. 6. The pressure of 2000 pounds at 8 inches distance from the center will exactly balance the pull of 800 pounds 20 inches from the center, because

$$2000 \times 8 = 800 \times 20.$$

Since the forward pressure on the crank pin is equal to the backward pull of the load × the leverage, in both cases, where does the long crank get any advantage in "leverage"?

Suppose a big man could lift exactly 300 pounds and no more, and a little man could lift exactly 100 pounds and no more. Could the big man lift his 300 pounds any easier than the little man could lift his 100 pounds? Not so you could notice it. The case of the long-stroke and short-stroke engines is precisely the same, so far as "leverage" and pulling the load "easier" are concerned.

COMPRESSION AND EXPANSION

The statements were made that a higher compression could be obtained with a long-stroke engine and that therefore the initial pressure will be higher, the expansion greater and the exhaust gases cooler.

Of course, if the clearance volume is the same in a 4x5-inch engine as in a 4x4-inch engine the compression would be higher, but no one who had the most elementary knowledge of gas engines would make the clearances the same. The compression pressure is limited by pre-ignition or safe maximum pressure on the moving parts, according to which limit is reached first. In gasolene engines pre-ignition always limits the compression pressure; in producer-gas engines the maximum pressures usually set the limit for compression.

When the builder decides what compression pressure to use, he makes the clearance space of the right volume to get it, no matter what the relation of stroke to bore may be. If a 4x4 engine will not stand more than a certain compression pressure without danger of pre-ignition, neither will a 4x5 engine. On the other hand, if it is safe to make the compression pressure of a 4x5 engine higher than that of a 4x4 engine, then the latter is too low and should be increased by reducing the clearance volume.

To get a numerical comparison of the various points brought up in paragraphs 3, 4 and 5, let us suppose that a small gasolene engine, say of 4 inches bore, cannot be operated reliably with more than 82 pounds compression pressure (absolute). The explosion pressure of such an engine will be about three times the compression pressure and the pressure when the exhaust valve opens will be a trifle over one-sixth of the explosion pressure or one-half the compression pressure. These proportions give the figures in Table 3.

Evidently there is no difference here in anything relating to cylinder pressures except the piston displacement and clearance volume. Now, supposing for the sake of argument, that the same clearance volume could be used in both engines, what would be the comparison? The figures in Table 4 give it clearly. Where is the expansion to lower exhaust pressure and the corresponding lower exhaust temperature? The truth is that statement 2 is absurd. The fact that the initial or explosion pressure is higher does not necessarily make the exhaust pressure lower. The expansion ratio is higher, of course, with a higher compression ratio, and this tends to increased efficiency.

But there is no ground for assuming that the compression pressure can be carried higher in a long-stroke engine than in a short-stroke engine of the same horsepower and using the same fuel. Therefore the comparison in Table 3 is the correct one.

There are true features of comparison which the writer of the article under discussion did not even consider. For example, the short-stroke engine has less wall surface in the cylinder and the heat loss can therefore be made less than in

TABLE 3.

Engine.	A	B
Cylinder	4x4	4x5
Piston area	12.57	12.57
Piston displacement	50.27	62.83
Clearance volume	16.75	20.94
Compression ratio	4	4
Compression pressure	82	82
Explosion pressure	246	246
Expansion ratio	3.8	3.8
Exhaust pressure	42	42

a long-stroke engine of equal power. On the other hand, combustion of the fuel at constant volume can be more nearly realized in the long-stroke engine because the piston is practically stationary at the end of the stroke for a slightly longer time.

TABLE 4.

Engine.	A	B
Cylinder	4x4	4x5
Piston displacement	50.27	62.83
Clearance volume	16.75	16.75
Compression ratio	4	4.75
Compression pressure	82	102
Explosion pressure	246	306
Expansion ratio	3.8	4.5
Exhaust pressure	42	44

These are points of minor importance, however; the main points are the greater wear and tear of the short-stroke engine and, on the other hand, the greater weight and cost of the long-stroke engine. The choice of stroke-to-bore ratio is a compromise between these opposing disadvantages.

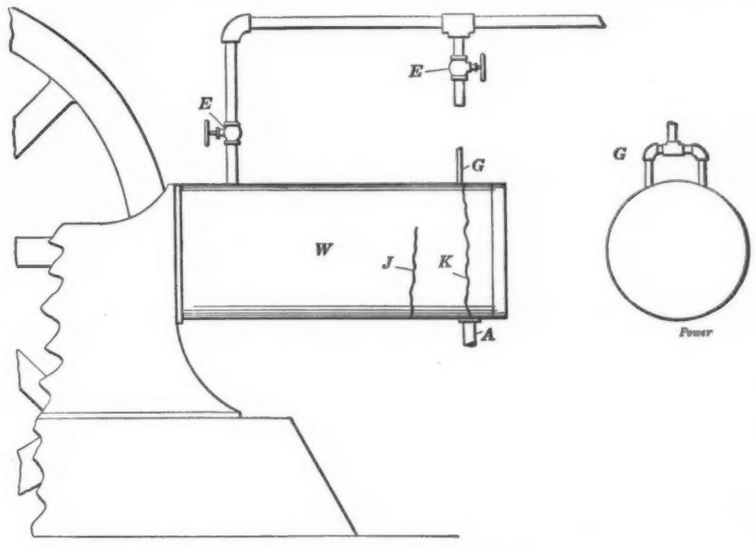
After you have studied a machine for weeks and understand the cause of the trouble, do not expect the boss to take your word for it, or expect him to understand all you try to tell him about it with one explanation.

CORRESPONDENCE

Mr. Booth's Gasket and Mr. Sanders' Cracked Jacket

In the issue of December 6, Frank E. Booth recommends the use of graphite on the gasket between the cylinder and head. I think that would be condemned by most engineers because the gasket would be more apt to blow out. In my experience with gas engines I have used a wire-inserted asbestos cloth in making that joint, and did not put anything on it. On removing the head I used a case knife to cut the gasket loose.

Referring to F. W. Sanders' article on the same page, I cannot see how reversing the flow of the water would change the pressure. I should say that the cool water entering at that point and coming in contact with the hot plate would set up strains that caused the leak. On reversing the flow the water would merely be warmed considerably before reaching this point.



WORKING WITH A CRACKED WATER JACKET

FRED ECKLEY.

Mohave City, Ariz.

Lignite mining and the manufacture of patent fuel are of growing importance in Germany, according to the British consul in Berlin, the constant increase in consumption being due to the fact that both materials are used for many more purposes in the present day than was possible formerly. New plants are now fitted up with steam boilers that have been specially constructed for the use of lignite and patent fuel. The existing lignite syndicates have established far-seeing organizations for selling lignite, and have forwarded their aims to no small extent by the introduction of stoves specially adapted for heating by briquets.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Making Pipe Covering

When tearing out or changing old pipe work, it is difficult to preserve the pipe covering, especially the cheaper grades, as it cracks and drops to pieces.

Many engineers throw away this old covering, and, in some instances, it is replaced with a new covering at a considerable expense.

The accompanying illustrations show how this old covering may be used to good advantage, and save the expense of purchasing new covering. *A* is a piece

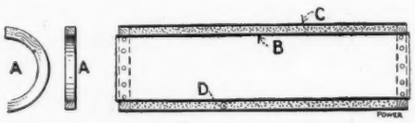


FIG. 1.

of wood about ¾ inch thick, cut in a circular form, the inner diameter being equal to the diameter of the pipe to be covered, and *D* being equal to the desired thickness of the covering.

One of these pieces is used at each end of the form, and a piece of sheet iron, bent to fit the outside of the pipe, is put on the inside of the circular pieces of wood.

Another piece of sheet iron is then bent to fit the outside of the blocks, and both are fastened by small bolts, running through the blocks, as shown at *C*.

The old pipe covering is then crushed or broken up, and mixed with enough water to make it work well. The form is laid in a horizontal position, and the plaster poured into the space between the two pieces of sheet iron *B* and *C*.

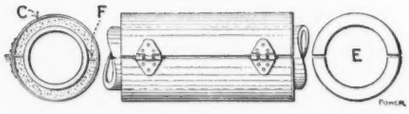


FIG. 2.

Care should be taken to push the plaster down well into the form, so that there will be no holes in the bottom.

If a little portland cement is mixed with the covering before the water is added, it will dry quicker and be more substantial. After it has dried for a few hours, it may be taken out of the form and put on the pipe.

Fig. 2 shows another form which is more convenient for small pipe and may be made for larger pipe, if desired.

Instead of using blocks, the two sides are made as shown and are hinged on one side. A piece of pipe the size to be covered is used for the inside of the form.

A ring *E* is cut, as shown, and one piece is soldered to the lower end of each side to hold the pipe in the center of the form. The covering is then poured in from the top. When it is dry, the form may be opened and the covering taken out.

The projections *F*, on the sides of the form, cause the covering to be cast in two pieces.

The covering will come out easier if the inside of the form is greased a little before putting in the plaster. This will prevent the covering from sticking to the form.

R. L. RAYBURN.

Kansas City, Mo.

Don't Neglect the Safety Stop

Our engine has a 12-foot flywheel and runs at a speed of 80 revolutions per minute. A 70-kilowatt generator is belt driven from a jack shaft. The generator was fitted with a 16-inch cast-iron pulley and ran at a speed of 600 revolutions per minute.

One evening this pulley burst, breaking the belt which flew under the rope drive, knocking the ropes from the flywheel and knocked off the governor belt. This would have resulted in a serious wreck if the safety cams had not been properly adjusted, because I was left in absolute darkness until I could get to the switchboard and throw the house-lighting switch on the other engine, which was in service at the time.

I am always very cautious about removing the pin or lever from the governor, and always instruct my assistants to be likewise.

A governor with the pin left in is as useless and dangerous as if it were not a safety-stop governor.

WALTER CARR.

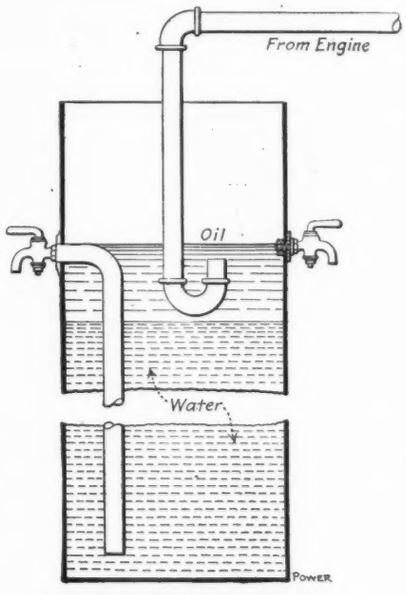
Harrisburg, Ill.

An Oil Trap

A couple of years ago I was running a 500-horsepower tandem-compound engine on which 50 gallons of oil was used per month.

Of course, this was out of all reason, but it was some time before I took a tumble to the fact that the oil was splashing back from the crosshead and guides into the stuffing-box drip and through a pipe into the sewer. Then I devised a separator, which may not be new to the "old heads," but I have never seen one like it, and it may help someone.

I took a can 24 inches deep and 5 inches in diameter, and soldered in a ¼-inch cock, 3⅞ inches from the top, for an oil drip.



DETAILS OF OIL TRAP AND PIPING

Then I soldered a piece of lead pipe, 20 inches long, to another ¼-inch cock and soldered in this cock at a point 4 inches from the top of the can, allowing the pipe to extend nearly to the bottom of the can. Next, I ran a ⅜-inch pipe from the engine cesspool, allowing it to dip some 6 inches into the can and ending in a return bend.

The can would fill with water and oil, the oil staying on top of the water of course, and the excess water passing out through the pipe. When four or five inches of oil accumulated, it would rise to the level of the oil drip and flow to the filter, while the water would flow to the sewer from the other cock.

After installing this device the oil bill dropped from $12 to $2 per month.

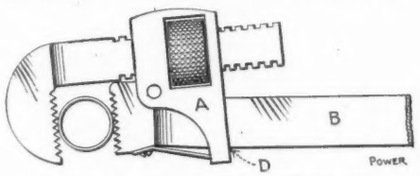
F. B. MILLER.

Defiance, O.

How to Use a Pipe Wrench

Every engineer knows that a pipe can be easily jammed by a pipe wrench, but if my instructions are carried out, one can be used on even thin pipes without jamming them.

Place the wrench on the pipe and get it to bite; then slack off on the nut until the frame *A* comes in contact with the



APPLICATION OF PIPE WRENCH

handle *B*, at *D* (see illustration), thus preventing the jaws from closing; the wrench then has power to turn, but not to jam the pipe.

H. A. GREENE.

Boston, Mass.

Exhaust Head Too Small

On taking charge of my present position, I found that an exhaust head had been installed on the exhaust pipe of the main engine. The exhaust pipe ran from the main engine to the feed-water heater, and from the heater to the atmosphere, and a drip pipe ran from the exhaust head to the heater. With a light load on the engine the exhaust head did its work very satisfactory, but with a heavy load it was not of sufficient size to handle the exhaust steam, and the moaning of the steam through the head could be distinctly heard for some distance. The head was removed and the superintendent did not miss it for nearly a week, when down he came to the engine room to know why I had removed it.

I told him I did not like the sound of the tune it was playing, for one thing, and for another it was difficult to convince the feed-water heater that it was right and proper for it to stop on the job while the exhaust head was in place.

He started for the office, but I got there first and told the manager I understood when I took charge of the steam plant that I was expected to use my best judgment and handle the plant as economically as possible, but that it would be impossible for me to do so if the superintendent was allowed to interfere. I never knew what the manager said to the superintendent, but on his next visit he said, "I believe you are trying to do the right thing around this plant, and I will try and help you all I can"; and he did.

Similar conditions prevail in a good many factory plants where the superintendent and foreman try to run the whole show, and block the engineer when they think he is showing too much ability, for fear that he may get on the inside with the management.

Who should be the best judge of what is right or what is wrong in the care and management of the steam-plant equipment, and who is the best judge of a fireman or assistant if it is not the chief engineer who has had years of experience and made a special study of the work?

W. G. WALTERS.

Stratford, Can.

Governor Arm Broke

About a year ago I was employed in a lighting plant that ran nights only. A 150-kilowatt alternator, direct connected to an automatic engine, was usually started up in the evening and ran until about 11 o'clock, when it was shut down and the load carried on a smaller unit until morning.

One night after the load had been put on the smaller unit and the big engine was being shut down, one end of the flywheel-governor bar carrying one weight broke off close up to the eccentric. I was called, but after looking over the governor I decided nothing could be done until morning, when the shops opened and tools could be obtained that I did not have at the plant.

At 8 o'clock all hands were ready to take off the flywheel and governor bar and try to put an iron strap around it and along the sides to hold it together until a new one could come from the factory. After working until noon and not even getting the flywheel key started, it was seen there would be no lights that night unless something else could be done.

The superintendent suggested that we block the governor wide open, which was done, and the remaining arm of the governor was clamped to a spoke in the flywheel. A pair of wires were run to a voltmeter near the throttle and a man was stationed at the throttle and regulated the speed of the engine by hand for three weeks, until the new governor came.

It was found that there was a bad flaw in the arm of the old governor and the bumping in shutting down finally found the weak spot.

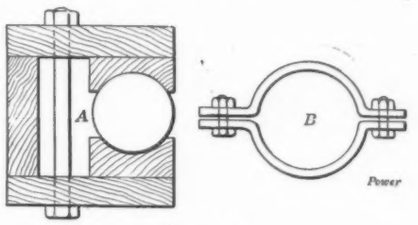
RUSSELL E. HAUSER.

Delta, Colo.

Pipe Clamps

A water or steam pipe may develop a bad leak while the plant is in operation and it is not convenient to cut out the particular pipe line for repairs.

If the leak is not too close to a fitting, a temporary repair may be made with a piece of sheet packing and a couple of



PIPE CLAMP

blocks of wood bolted together as shown at *A*, or a heavy sheet-iron clamp may be made as shown at *B* in the accompanying illustration.

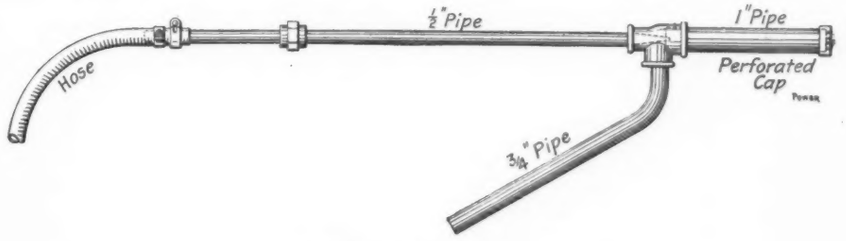
CHARLES H. TAYLOR.

Bridgeport, Conn.

Homemade Tube Cleaner

Some concerns will not invest in the necessary apparatus for the power department, and then it is up to the engineer to do the best he can. The accompanying drawing shows how a tube blower can be made out of a few fittings.

This blower consists of a piece of ½-inch pipe 18 inches long and tapered at the end; that is, screwed into a tee, the end coming to a point beyond the center. On the other end of the tee is screwed a piece of 1-inch pipe; it is screwed in so that the end reaches to the tapered end piece of the ½-inch pipe.



HOMEMADE TUBE BLOWER

On the end of the 1-inch pipe is screwed a 1-inch perforated cap which serves to scatter the steam into a number of currents which pass into the tube and cleans it of soot.

A piece of ¾-inch pipe is screwed into the side outlet of the tee and when steam is turned on the device acts as a siphon and draws a current of air through the handle and prevents it from heating so that the handle to the cleaner is always cool.

E. H. MARZOLF.

Bellaire, O.

Getting the Position "Higher Up"

Much has been published in regard to becoming a more efficient engineer in order to assume greater responsibilities. Very little has been published, however, about how to secure the job higher up. It is more of a task to secure the job after one is fitted for it than some seem to think.

To illustrate, a certain uptodate engineer I know is young and progressive and has never let a chance slip whereby he could better himself. He holds a diploma from a correspondence school, is well versed in electricity, combustion and the multitude of things that a first-class engineer should know, and without a doubt is an A No. 1 engineer in every way. His present employer has told me that he is the best engineer he ever employed (and he has employed a good many). Now, in view of the fact that we read good men are always in demand, this man has been trying to get a better position for over two years without success.

Probably one reason why an engineer does not "get next" to better jobs is because he is tied down so close and does not have the opportunity to hear of the openings and is greatly handicapped in that way.

I would suggest that the boys give us their ideas on the following: If an engineer is desirious of securing a larger position, how should he proceed to get it? It is assumed that he is capable of holding it in every way.

OSCAR J. RICHMOND.

Bridgeport, Conn.

Federal Laws

In reading Mr. Blanchard's letter, published in the January 10 issue of POWER, I noticed that he mentions a bill that is to be considered by Congress, relating to the Federal inspection of all locomotive boilers in the United States. I saw a copy, or rather, it was supposed to be a copy of this bill some time ago, and, if I remember right, the Boilermakers' Union is "fathering" it. I noticed one paragraph in particular which reads about as follows: "No applicant will be examined for the position of boiler inspector unless he has had at least five years' practical experience as a journeyman boilermaker." It seems to me that by inserting this clause in the bill the Boilermakers' Union is trying to form a sort of monopoly of all the inspectors' jobs that will be created if the bill becomes a law. We have quite a few good boiler inspectors in the State of Massachusetts and I venture to say that a large percentage of them have not had five years' practical experience as journeymen boilermakers.

I fully agree with Mr. Blanchard in regard to a Federal boiler-inspection and stationary engineers' license law. This would most assuredly be a step in the right direction. In my opinion it is up to the National Association of Stationary Engineers to start the ball rolling.

FRANCIS CLEGG.

Taunton, Mass.

Removing Oil from the Eye

Oil in the eye causes a burning, itchy feeling, but relief can be obtained by filling a wash basin with luke-warm water, in which a teaspoonful of table salt has been dissolved. Then put the eye in the salt water and open and close it slowly a few times.

Next fill the basin with cold water and, after opening and closing the eyes under water, dry them on a clean towel, but do not rub them.

Salt water cuts the oil, and the cold, clear water rinses the eyes and invigorates them.

WILLIAM E. DIXON.

Malden, Mass.

Fitting Piston Rings

Two rings of the snap type were turned ¼ inch larger than the cylinder and had to be cut slantwise before it would fit the cylinder. About ¾ inch had to be cut off and when a ring so treated is sprung together and forced into a cylinder, the sharp points will keep a considerable part of the ring from bearing against the cylinder walls. I therefore filed these points down and rubbed the rings in a bore provided for the purpose and spotted them to an all-round bearing.

Some engineers might expect the rings to wear to a fit. Suppose they will do so without scoring the cylinder, there would be a waste of steam during the wearing process and the result would be an unnecessarily large opening at the joint.

I fitted the rings to the grooves just tight enough to hold the joints together but so they could easily be moved by tapping them with a hammer handle. I have been told that this is much too tight, as the rings should be loose enough to slide in the grooves, or otherwise they would not expand against the cylinder walls.

If piston rings are fitted so that the spring is just compensated by the friction in the grooves, they will expand as soon as the piston begins its reciprocating movement.

If the rings are loose enough to slide they certainly have a side movement, which will increase, and cause them to rattle in a short time. I do not advocate the indiscriminate use of a coarse file, nor do I believe in jamming rings into the grooves, but in carefully fitting them both ways.

H. WIEGAND.

Chicago, Ill.

Water in the Turbine

One morning I dropped into the power house of our electric-light company and the operating engineer was running a high-pressure turbine of 1500 kilowatts capacity. All at once the lights began to grow dim, as the machine began to slow down. The turbine did not sound as though overloaded.

Engineer and switchboard operators were looking for a short-circuit and, being satisfied there was none, the engineer ran to the turbine and was about to make adjustments to speed it up, at the same time giving orders to the oiler to get an exciter and engine ready to cut in, when the lights came on and it seemed that everything was all right; but in about 30 seconds down went the lights again.

Finally the trouble was located in the boiler room; one of the firemen had let his boiler fill up with water and, of course, the machine did not make a very good water and steam turbine. The water did not cause any damage, as when it was lowered everything went along as usual.

Steam was carried at 140 pounds and, the water being high, slugs of it passed over into the turbine.

By being present at that time I got a little education in the variation of sound between a short-circuit or overload and water going into a turbine.

L. O. HUSTED.

Curtis, Colo.

Homemade Babbitt and Belt Dressing

If mining machinery in the mountains, or the drilling outfit of the prospector, miles from civilization, suddenly breaks down, it taxes the resources of the attendant to make repairs and keep things moving.

I recall an experience in the "Rockies" where it was absolutely necessary to have a quantity of good bearing metal at once, and the outfit was 160 miles from the base of supplies. The problem was solved by making a sacrifice of a copper wash boiler from the cook house, and by melting the solder from a collection of tin cans. These, combined at the ratio of one pound copper to ten of the solder, gave us splendid results. Subsequent experiments have shown that an alloy of twenty parts zinc, one of copper and three of tin give an all-round metal very hard to improve upon.

An excellent emergency belt dressing can be made as follows: Take 25 parts of linseed oil and 12 parts of turpentine; heat in a water bath and add 12 parts of pulverized rosin. Stir the mixture thoroughly and allow it to cool. Should the oil, turpentine and rosin not be available, castor oil with 10 per cent. of tallow added makes a very good dressing.

EDWARD VAN ANTWERP.

Brownsville, Tex.

Questions Before the House

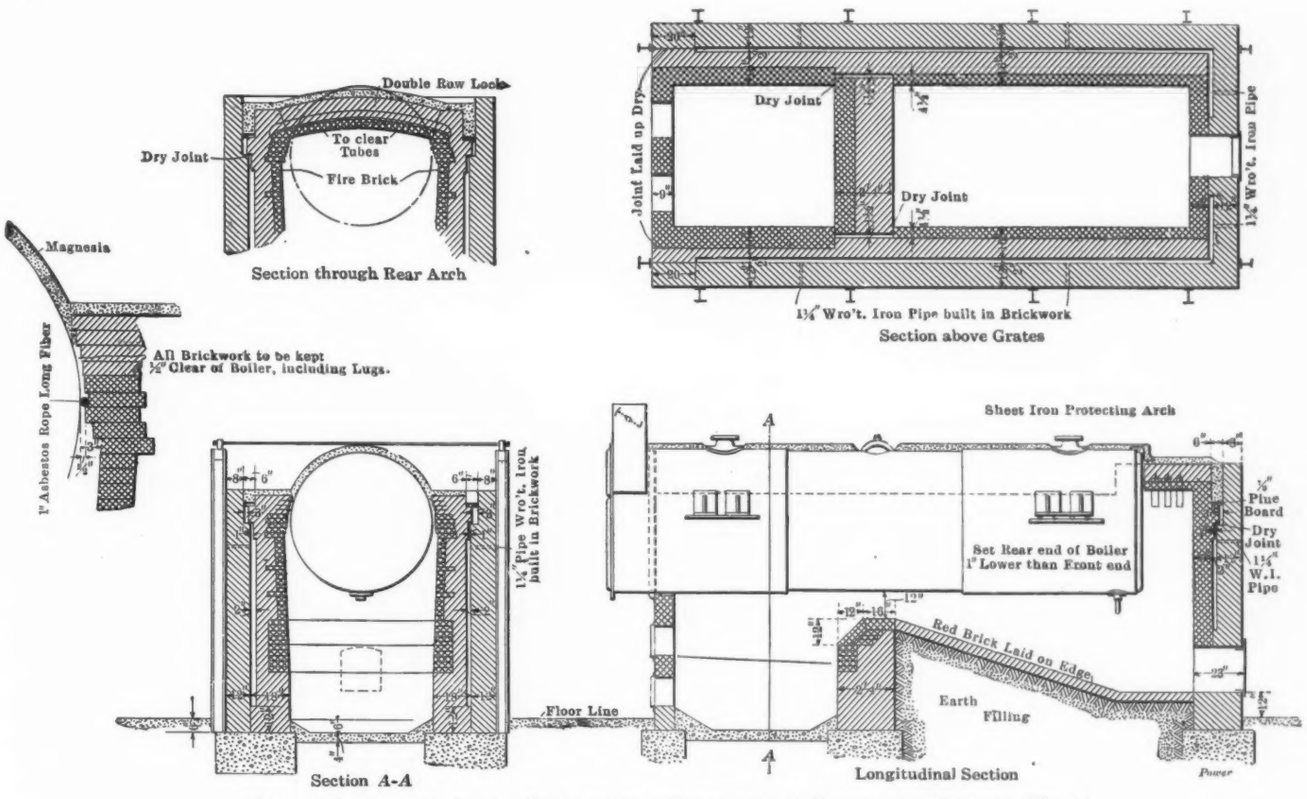
Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Setting Horizontal Tubular Boilers

I read with considerable interest S. F. Jeter's excellent and instructive article on "Setting Horizontal Tubular Boilers" in POWER for January 3. Supplementary to this article I would say that it is the aim of an engineer to so design the brickwork of a horizontal return-tubular boiler setting that it will be as free from cracks due to expansion as possible.

Figs. 2 and 5 of Mr. Jeter's article show the sections of settings as commonly designed and built, in which the inside and outside walls are bonded together at the top of the air space above the horizontal center line of the boiler. When a boiler is in operation the inside walls of a setting are necessarily much hotter than the outside walls and the expansion of the inside walls will of course be the greater. To avoid cracks from this cause I consider that the inside walls should be free to move from this cause independently so far as possible.

The accompanying figure shows a setting which I designed a few years ago with this point in view. This design is used as a standard for boiler setting in the office of Charles T. Main, engineer, Boston, Mass., and a number of boilers with settings so built have proved very satisfactory. The figure is clear enough to be self-explanatory.



BOILER SETTING TO ALLOW INDEPENDENT EXPANSION OF INSIDE AND OUTSIDE WALLS

I presume that some may question the object of the 1¼-inch pipes built into the outside walls near the top of the air space. This is to allow a free escape of the vapor arising in the air space as the walls dry out after the boiler is started up. This is not original and is the practice of not a few in boiler-setting design. I do not know whether there is any virtue in it or not, but I do not see that it can cause any harm and it may do some good, and the pipe can be plugged with cement after the brickwork has dried out.

F. B. COLE.

Boston, Mass.

Troubles of a Refrigerating Engineer

In the December 27 issue, Mr. Walters writes about trouble with his refrigerating system. Mr. Walters does not state what kind of a machine he is running. According to his explanations he has what refrigerating engineers call a "dry system"; that is, an outfit without an oiling system (oil cooler, etc.), such as furnished by the Pennsylvania Iron Works, Frick, York, Vilter, etc. With all of these machines except the Vilter the ammonia compressors are built vertical. As I do not know what kind of a machine Mr. Walters has, I will take the Vilter machine as an

example. This machine has a horizontal compressor. A small pump, driven from the engine shaft by a belt is used to supply with oil the sleeve through which the piston rod works. The oil in the sleeve serves to keep the piston rod from getting hot. Sometimes oil is taken with the piston rod into the compressor. There is also a connection on the suction of the machine to supply the cylinder and valves with oil (ammonia liquid base) now and then.

The stuffing box of Mr. Walters' machine must be in a bad condition, possibly too much clearance exists between the piston rod and the back of the stuffing box. This will permit, after the packing gets worn some, too much oil to get into the compressor, and finally the packing goes the same way. I cannot understand, however, how Mr. Walters could find bits of packing, etc., in pockets in the high-pressure side of the system unless the system was flooded with such matter.

The machine discharges the ammonia and some oil into the discharge tank; the oil falls to the bottom of the tank, while the ammonia gas passes into the condenser to be liquefied and from there as a liquid into the liquid or pressure tank. The discharge tank is provided with a glass gage to indicate the hight of the oil in the tank. Of course, when the passages of the gage cocks are clogged, it is impossible to see the oil. The liquid or pressure tank has also a gage so that one can tell by opening the cock how much liquid is in the tank. In case some oil does get into this tank it will not do any harm; but, if so desired, it may be removed. From the discharge ports of the machine to the liquid tank, including the condenser and storage tank, is the "high-pressure side" of the system. The ammonia liquid is forced through the regulating valves (or expansion valves, as they are often called) to the expansion coils. If the ammonia is free from oil or other substances and not turned on too full, it freezes the coils connected to the suction of the machine. The part of the system from the regulating valves to the compressor is called the "low-pressure side" of the system.

If Mr. Walters will put a metal ring at the bottom of his stuffing box, use a good grade of packing, clean out the discharge tank and, if necessary, the liquid tank, he will find a great difference in the operation of the system. Should he still find the regulating valve to be operating badly, if he will replace it with a new one the trouble will stop. He should shut off the main liquid cock or valve first. All of the regulating valves in the different rooms ought to be marked so that they may be set at the same point again after the new regulating valve is in place. Sometimes one or more of these valves leak; this causes considerable trouble when pumping out one room separately, therefore, he should open them all. Pump the system down to zero, stop the machine and after a while start up again and pump down to zero once more or even a little lower. Not until the low-pressure gage hand remains where it was when the machine was stopped the last time is the system empty. Rap the gage slightly as the hand may hang a little. The suction and discharge valves on the machine may be closed if they are suspected of leaking. If the hand on the low-pressure gage remains at zero, it is safe to break a flange on the valve to be taken out and let the oil, if any, mixed with some ammonia out. Perhaps in Mr. Walters' case the main liquid valve was leaking, or perhaps he did not pump out properly.

In the case of a leaking main liquid valve, the effect will be noticed on the low-pressure gage, the hand will still rise after the system has been pumped back several times in succession.

To replace a valve, get all tools ready that may be needed. Have all of the nuts working easily. Start the machine, pump down to zero or a little below and keep the machine turning just fast enough to keep the pressure below zero. Then, have a good helper ready with a stopper; take out the old valve and have him close up the pipe. After everything is ready, remove the stopper and put in the new valve. If each one knows what to do, it will not be long before the new valve is in place; the quicker this is done the better. Whatever little air that is pulled into the system should not do any harm.

WILLIAM L. KEIL.

Philadelphia, Penn.

Hotel Power Costs

O. L. Sherman asks in the January 3 issue for data on hotel and office-building power plants. My letter in the December 20 issue will give him some figures as to power costs.

The statement for the month of October, 1910, in the above mentioned letter did not contain the total output of the generators for that month, which was 51,750 kilowatt-hours, which makes the cost per kilowatt-hour 2.36 cents. This was brought about by the large sale of current for that month.

As to the cost of the installation per kilowatt, this would depend upon the size of the units, the larger the units the lower the cost per kilowatt.

I take it that Mr. Sherman is in charge of a hotel plant where current is bought from the central station, and the remainder of the power is generated at the hotel. High-pressure steam for the laundry and kitchens is required, also for the pumping equipment and perhaps for the refrigerating machine, and, unless he has electric elevators, these also require high-pressure steam.

He probably has a boiler plant and equipment capable of carrying 100 pounds pressure. As it takes but very little more steam-generating capacity for a generating plant when the exhaust steam is used for heating purposes than when live steam is used to heat the building, he probably would not have to add to his boiler equipment in order to operate electric generators.

The size of the units will depend on the size of the hotel, that is, on the number of rooms used for guests.

Considering all from the above standpoint, and assuming that he has a "250-room house," he would get a night lighting load of about 100 kilowatts, taking in the outside lights and the roof sign, if he were using carbon lamps throughout. If he were using tungsten lamps, it would bring the load down considerably. If he has electric elevators, these would necessitate large units.

Under the requirements for lighting he would require one 100-kilowatt unit for the night load and one 50-kilowatt unit for the day load. This would leave him no spare unit for the night load in an emergency. He might have a "breakdown" connection with the central station; otherwise he would require one extra 100-kilowatt unit.

As to the cost of installation, if he did not have to enlarge the boiler plant, but just installed the steam and exhaust piping and the generating set, the cost would be approximately $45 per kilowatt, complete, including foundations, erecting, piping and pipe covering.

If an extra boiler had to be installed, it would cost from $10 to $15 per horsepower, depending on the size of the boiler. This would cover the cost of a complete boiler installed.

As to which would be the more economical, turbines or reciprocating engines, I could not say; but it seems to me that for small units, reciprocating engines would be better. One thing is certain, whatever type of machine is decided upon, it must be a quiet running one, as vibration or a singing noise would not, or cannot, be tolerated in a first-class hotel.

Mr. Sherman will do well to have all foundations built heavy and substantial, and, if possible, have all steam mains supported from the floor instead of hung from the iron work of the building.

Another point that might be of use to Mr. Sherman is that if he is considering the installing of a generating plant, and if his building is located in a business section where there are office buildings and stores near by, he could derive (by installing larger units) a good income from his plant by selling current outside for light and power purposes, and surplus exhaust for heating, also hot water for domestic use.

He could charge for the current at just a little under the rate of the central sta-

tion and get plenty of customers. The steam he could charge for at the rate of from 40 to 60 cents per 1000 pounds, depending on the cost of coal; or, if he did not want to install a water weigher, he could charge a flat rate of from $4 to $5 per 1000 cubic feet of space to be heated.

From my plant I take in from $250 to $575 per month for light, heat and ice, depending on the season of the year. I have a very good customer, a theater, to which I furnish both heat and light.

WILLIAM J. BEDARD.

Rochester, N. Y.

Placing the Responsibility

If the authorities to whom is intrusted the duty of investigating and placing the responsibility for boiler explosions would conduct them more after the manner of common police-court investigations, there is reason to believe that a marked decrease in the number of failures would be the result.

Every boiler-explosion investigation that I have ever heard of or read about has apparently been conducted with the object in view of placing before the public a report that contained far more material for the scientific mind to consider than to place before the criminal prosecutor evidence that would show if there had been a probable guilt of criminal carelessness.

What has been the result? So far as I can ascertain no one in this country has ever been criminally prosecuted in connection with any of the thousands of boiler explosions that have occurred since steam boilers became at once a menace and a necessity to the public welfare.

If it were not for the appalling testimony of death and destruction intermixed with the reports of these investigations the reading of some of them would be amusing.

In the early days a report was sure to state that "the engineer admitted cold water into an overheated empty boiler"—especially was this the verdict if the engineer had disappeared with the explosion, as was often the case. This form of report eventually became unsatisfactory, for if the engineer lived he would sometimes contradict and possibly prove that such conditions did not exist.

Overpressure has always been a good explanation to hand to the public when it was bowed down with grief over the premature departure via the boiler-explosion route, of fellow townspeople, it being understood that "overpressure" was merely incidental to the operation of a boiler.

The ironmaker should be held more strictly to account for failure to use the best material and the best process for the manufacture of the iron and steel for the particular use it is intended for.

The boilermaker should be required to follow more stringent rules and should be held to account whenever investigation showed that a boiler had been improperly or carelessly constructed.

The owner should be held accountable for having in his possession a boiler that could in any manner become an unnecessary menace to public safety. He should also be held responsible for the selection of the operatives to whom is intrusted the care of the boiler.

The operatives should be held responsible for the condition and management of the boiler and the condition of appliances that pertain to the safety of its operation.

The inspectors and boiler-insurance companies should be held to a far more strict accounting than can be estimated in dollars and cents for the unfaithful performance of the duties which the words suggest.

Statistics show that comparatively few boilers explode up to a certain age. Then, why should not that age be made the limit for the term of use?

In nearly every instance when a boiler explodes, some circumstance will be brought out that will indicate that dollars were weighed against human life and the dollars weighed the most.

JOSEPH KING.

Boston, Mass.

Air Pressure for Lifting Water

The answer given to the inquiry of A. L. W., in the January 3 issue, in my opinion is not correct.

The air pressure necessary to operate an air lift is governed entirely by the submersion and the friction of the air line, and would be the same whether the lift were 50 feet or 200 feet, although the volume of air required would vary with the lift. The formula would be

$$\textit{Submersion} \times 0.434 + \textit{friction of air line} = \textit{pressure.}$$

The air pressure required to operate an air lift with 200 feet submersion with an air line of proper size should not exceed 90 pounds. The quantity of water lifted has no effect on the air pressure. The work performed in an air lift is entirely due to the buoyancy of the air and the compressor has no effect on the air after it is liberated at the bottom of the well.

In reference to the statement that the air pressure is "never less than is required to support a column of water of a hight equal to the lift," this would be true if we were lifting a solid column of water, but the weight of the column is greatly reduced by being mixed with air bubbles.

In regard to this I wish to call attention to the article on the Starrett pump in the March, 1905, issue of POWER, which actually lifted water 300 feet with 40 pounds air pressure and on which the patent office at first refused to grant a patent on the ground that the pump would not work. A number of these pumps have been in successful operation on the Pacific coast for a number of years.

G. A. REICHARD.

Los Angeles, Cal.

Graft

An editorial in the January 10 issue does me the honor of criticizing the communication that appeared over my name in the December 20 issue, entitled "An Engineer's View of Graft." As the editorial so controverts the facts and shows that the opinions I expressed have been misunderstood, I will endeavor to make clearer my ideas as set forth in those parts of the article that the editorial criticizes.

Ability to write so as to be understood is comparatively easy, but to write so that you cannot be misunderstood is an art; this possibly explains why more engineers do not write, a question recently propounded in these columns.

The editorial states that the opinion expressed "is not calculated to accelerate the movement for the abolition of graft." I wish emphatically to state that no such acceleration was intended if, as my article states, the accepting of the usual tokens given in return for *honest* patronage is to be considered as "graft."

I regret that the editorial did not define the meaning of the word, as one object of my writing was a curiosity to ascertain the sense of the word when applied to engineering.

A great deal of the sentiment expressed in the picture of the "Employer conspiring with his engineer to get more out of the seller of supplies than the face of the bills calls for" depends on the point of view. Considered from an office chair and biased by the assurance of a large salary the subject is apt to present a very different aspect than the view of a man sitting on the edge of a coal bunker, cogitating on the dismal foreboding that the grocery bill will have to go over another week in order that the "kiddie" may have a new pair of shoes.

The idea expressed by the term "conspiracy" has been considerably perverted from what was intended. Instead of "conspiring" to get more out of the seller of supplies than the face of the bill called for, the employer merely sanctions the acceptance of part of the commission that, if not received by the engineer, would remain in the bulging pocket of the salesman.

The simile of "master and menial" in some cases is very good as the engineer works for from 12 to 14 hours a day, six days a week, and receives something like $14 each week for his services. After working a short time under these condi-

tions you can call a man most anything without injury to his feelings.

I cannot answer the conundrum, "Where are the high ideals of the professional engineer?" as I do not believe he has any, my conception of the term "professional engineer" being—One who can receive as *fees* and *commissions* what to the ordinary work-a-day engineer would be considered just plain "graft."

As I particularly desire to be considered among the "immunes," will my criticizer kindly answer the following: Does the acceptance of the premiums offered for the securing of subscribers to POWER, or the premiums offered by advertizers for the purchase of their goods, or the acceptance of a consideration for writing this article, consign me to the "black list"?

AMOS SKEG.

Saugus, Mass.

Experience of an Indicator Man

We are all big children, and like children, like to have the last word.

I would like to reply to Mr. Wheat's comment in the January 10 number on my letter in the December 6 issue. My remarks referred to an article in the issue of November 15, which described a case where an engine could not carry the load, and, upon applying the indicator, it was found that there was 68 pounds mean effective pressure in one end, and only 15 pounds in the other. Now, I think that anyone will agree with me that no such state of affairs could exist, unless the cutoff was so badly out of adjustment that one might say that it was not adjusted at all, and the engine was very little better than a single-acting engine having one power stroke per revolution. I, therefore, maintain that it should be apparent to the novice.

It is customary for erecting men to block up the regulator on Corliss engines about ½ inch and then, while the engine is running slowly, to set the cam rods so that both cams will just unhook the valves. They know all about the effect of the connecting rod on the piston travel, but they leave that refinement to be corrected by means of the indicator. There is no trouble in getting the engine to deliver its full power and with economy. The same might be said about setting the rods from the wristplate to the valve cranks, and locating the eccentric on the shaft. These adjustments are all made by marks on the ends of the valves and the ends of the valve ports, when the cylinder is cold. Heating up the cylinder distorts these adjustments to some extent. Also, the shop men are sometimes careless in marking the valves and cylinder, and to get these adjustments right, the indicator must be used; but, speaking in a general way, setting the valves and cutoff in this manner is correct, and adjustments by the indicator afterward are in the nature of refinements.

W. E. HOPKINS.

Torrington, Conn.

I think that Mr. Wheat is too severe with Mr. Hopkins in his letter in the January 10 issue under the above title. I do not believe that Mr. Hopkins meant that an absolutely even cutoff could be obtained by adjusting the dashpots by the eye, and it would seem as though the difference in the rise would have been noticeable and if adjusted so that the rise looked about even, or even if the rise were equalized by the use of a rule, the engine under discussion would have had a much nearer equal cutoff than when found by the indicator man. Of course, this could be improved by giving the crank end more rise; according to one's general experience or knowledge of that particular engine. I know of one in which the difference in rise necessary to equalize the work is ¼ inch.

With engines on which the cutoff can be adjusted while running and which are direct connected to electric generators, the indicatorless man can even up the work done in each end of the cylinder by watching the vibration of the voltmeter pointer and noticing which stroke allows the finger to drop back, giving that end a longer or the other end a shorter cutoff until the finger is steady. Diagrams taken from each end after this adjustment alone might not be of the same shape, but if care were taken in setting the valves, knowing that there was no indicator available with which to check the operation, and then, if after the load on the cutoff was adjusted by the voltmeter, it would seem as though a fair job of valve setting would result.

A. N. BOGART.

New York City.

Effects of Cold Air

In answer to H. C. Fiske, relative to cold air admitted over the fire, I will say that as engineer engaged by the smoke department of one of the Middle West cities I frequently resorted to this practice for one or two reasons. First, the coals in use at that place are very high in volatile contents and there is a great volume of gas distilled during the first three to five minutes after each firing. These gases require a vast amount of air to supply the required amount of oxygen necessary for complete combustion. This air cannot be supplied through the grates as the green fuel just added has temporarily cut off this source of supply. The second reason is that when the rate of combustion is high, the temperature in the furnace is so great as to distil the above mentioned gases in such volume as to be beyond the control of the furnace operator, but, by admitting cold air through the furnace doors, the temperature can be controlled and much better results realized.

I have experienced a good deal of trouble from practical and experienced engineers and firemen who object to this practice for fear of the resultant effect on the boiler; but, after extended experience, I feel confident that no ill effects are caused by a judicious supply of air over the grates in horizontal return-tubular and water-tube boilers, although judgment should be used when this practice is applied to locomotive, Scotch or economic boilers.

H. M. PURNELL.

Erie, Penn.

Pittsfield Boiler Explosion

From information about the Pittsfield boiler explosion gathered from the daily press, as brought out by the coroner's inquest, it would appear that the boiler was fired up previous to the morning of the explosion, and that the safety valve blew freely when the gage registered only about 20 pounds. It was supposed that the gage was out of order and it was removed and brought to the city to be tested. The test seemed to indicate that the gage was correct and it was put in place again. When the boiler was again fired up the safety valve blew at the same pressure. Thinking that the steam gage was correct, it was natural to suppose that the safety valve was out of order, and to alter the tension spring.

It is possible that the engineer first gave the adjusting nut one full turn and waited to see how high the pressure would rise. Probably the valve blew again when the gage showed only a slight increase in pressure. The conditions at the ice plant on this morning possibly were something like this: fine ice-harvesting weather; 100 or more men under pay waiting for the engineer to start up; the owners fussing around, and the engineer a little rattled. What would be more natural than for the engineer to think to himself, if one turn on the nut only increased the pressure two or three pounds, I'll turn the thing down far enough at once and run according to the steam gage, which he proceeded to do.

The expert from the valve makers, the man who set the valve in the shop, says that the nut was screwed down twelve threads lower than when the valve left the factory. In my opinion it was down so far that the spring became practically a solid bushing, and I do not think the valve would have blown off at any pressure.

The results of this accident are deplorable, and the friends of the victims deserve much sympathy; it seems too bad that a little more gray matter was not used in the operation of this plant.

GERALD GRIFFIN.

Hartford, Conn.

Cause of Boiler Explosions

The numerous recent boiler explosions tend to confirm the theory which I have long entertained. Investigations seem to show that the length of time that a boiler has been in service has a strong influence on its safety. This is due to the change in the texture of the metal more than to the wearing away of any particular part of the boiler shell. A new piece of boiler steel can be bent double without showing any fracture; but, a piece cut from a boiler which has been long in service will not stand this test. This is especially true of the thicker plates. The farther the water is removed from the fire, due to the thickness of the plate, the more rapidly does crystallization of the shell seem to take place.

The editorial in a recent issue of POWER in which it is urged that the life of lap-seam boilers be limited, is eminently to the point. There should be an age limit for all boilers of lap-seam construction. The date of construction should be stamped in a conspicuous place on each boiler so that the length of time it has been in use may easily be ascertained.

Another point is that inspections should be more numerous and more carefully and thoroughly made. If it costs more to make such inspections raise the price of the insurance. Often, inspectors do not have sufficient time to make good examinations. There seems to have been too many points that were overlooked by the inspector recently which have led to disastrous results.

C. R. MCGAHEY.

Baltimore, Md.

In the discussion of boiler explosions, some express the opinion that the opening of a stop valve too quickly might cause a boiler explosion in accordance with the theory that a sudden relief of pressure causes an upheavel of the water against the shell with explosive force. Others maintain that if this were possible, boilers might explode by the mere popping of the safety valve.

Tests made upon different makes of pop-safety valves, as recorded in a paper read before the American Society of Mechanical Engineers in 1909 by Phillipe E. Darling, showed an average lift of 0.07 of an inch at opening for the 4-inch valves and 0.061 inch lift at opening for the 3½-inch valves. So, the discharge area of the 4-inch valve was

$0.07 \times 3.1416 \times 4 = 0.879$ *square inch.*

Opening a stop valve quickly would give many times this area and a correspondingly greater discharge. As a safety valve often sucks up water, a stop valve would be much more likely to do so if opened suddenly, and perhaps cause destructive water hammer in the piping.

B. N. EVERETT.

Jamestown, N. Y.

"Something Just as Good"

Upon reading the ad. editor's page in the January 10 issue, I was reminded of an experience I had with a sample of "just as good" hydraulic packing.

I was induced to try a sample, so I packed both plungers of a duplex boiler-feed pump, using three rings in each plunger. This pump was used at night and kept in reserve in the day time. The packing was recommended for hot water and the pump took its supply from a large tank which received the return and pumped through a closed heater to the boilers.

On the third morning after the pump had been packed the night fireman reported that the pump would not throw any water. I at once opened the water end and found the trouble. Of the six rings that I had put in, all were gone but two and these certainly would never be recognized as rings; they looked like bunches of cotton waste.

I repacked the plunger with the packing that I had always used and thought that the trouble was over. But it had only commenced. At noon we had to take the caps off the check valves on the feed-water pipes of three boilers and take some of that packing from under the clappers. That night we had to clean out the check valve on the closed heater; two days later we had to shut down the No. 1 boiler on account of the lower connection to the water column being clogged up. A few days later we had to take off the blowoff cock of the No. 3 boiler as that boiler did not blow down freely. In this boiler we found enough of that packing to fill a quart measure; some of it was in shreds and some was in small lumps like pulp. I have often wondered how they ever got it into ring form.

It certainly did *look* just as good as any other packing, but I found that looks were deceiving and the trial of that "just as good" cost me a few dollars, plenty of worry and a good amount of hard work.

I am now waiting for another visit from that drummer. I am very anxious to have a good confidential chat with him about "just as good" goods.

M. T. MARKHAM.

Burlington, Vt.

Selection and Use of Packing

While Charles H. Taylor, in the January 3 number of POWER, has given a good lesson on the above subject, he has made one statement that upsets a theory of long standing. It is an accepted theory that one surface in moving over another produces a friction which is proportional to the total pressure between the surfaces regardless of the area of contact.

As an illustration of this it will be found that a common building brick will require the same amount of force to drag it across the floor when it stands on edge as when it stands on its side.

Mr. Taylor's statement that a packing with a flat side in contact with the rod produces the least friction because the pressure is more evenly distributed, is not in accord with the theory of friction.

T. E. HAUGHT.

Means, Ky.

The Engineer's Education

W. G. Walters has something to say in the January 10 issue about chemistry for engineers. I find that in a great many cases engineers are sacrificing their chances of securing a first-class practical education to fill up during every hour of spare time on chemistry, and the theory of hydraulics, pneumatics, electricity and a dozen other things. These are all good to know, but any man who gets a good working knowledge of mathematics, steam boilers, gas and oil engines, electricity, steam engines, refrigeration and the hundreds of other things essential in a modern average steam plant, cannot possibly get time to become expert in a dozen different professions.

Every engineer must learn a little about chemistry and other things. Some engineers who write for POWER try to convince the readers that they are well up in all of the subjects just mentioned. I have spent several years studying the theory of steam engineering and it has proved of vast assistance to me. But I got my practical education first.

I would advise young engineers to visit as many different steam plants as possible, and when a thing is seen and not understood to ask questions. As Mr. Walters suggests, try to get an idea of the chemistry of the things most important in the plant, as water, coal, etc., but for your own sake do not attempt to wade through the hundreds of things in chemistry and the like that can never possibly be of any use in the engine and boiler rooms. If you must neglect one branch of engineering do not let it be the practical side, and remember, no engineer ever will rise to the top if he has no technical knowledge. But remember also that the technical expert with no practical experience is not a safe man to have charge of any plant, no matter how small. When I say the top I mean chief in a steam plant, that is about as high as any engineer with a little knowledge of a dozen different trades and professions can get. This is the day of the specialist, for it has been proved beyond controversy that it takes a lifetime for even a smart, brainy man to make himself a first-class expert in any one of the many different trades or professions into which every engineer must dabble more or less.

JAMES E. NOBLE.

Toronto, Ont.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Governor Pulley and Engine Speed

If an engine having an 8-inch shaft runs 200 revolutions per minute, what diameter of pulley will be required on the governor to drive it 256 revolutions per minute?

T. E. H.

The circumference of a circle is 3.1416 times its diameter.

The 8-inch shaft at 200 revolutions will pass

$8 \times 3.1416 \times 200$ *ft. of belt per min.*

The pulley will at 256 revolutions pass

Diam. $\times 3.1416 \times 256$ *ft. of belt per min.*

and these, of course, must be equal to each other for the same length of belt passes over both pulleys in the same unit of time. Then,

$$Diam. \times 3.1416 \times 256 = 8 \times 3.1416 \times 200$$

$$Diam. = \frac{8 \times 3.1416 \times 200}{3.1416 \times 250} = 6.25 \text{ in.}$$

Since the rim speed of the pulley is inversely proportional to the diameter and directly proportional to the rotative speed, the 3.1416 need not be considered and the case may be stated as one of inverse proportion.

Sp. of Gov.	*Sp. of Eng.*	*Dia. of Shaft.*	*Dia. of Pulley.*
256	: 200 ::	8	: 6.25

Size of Pump for Given Boiler

How is the diameter of the water cylinder of a pump suitable for feeding a boiler calculated?

J. F. M.

First find the number of gallons of water that will be evaporated per minute, then decide the number of strokes to be made per minute by the pump. Multiply the number of gallons by 231; divide this by the piston stroke in inches; divide this by the number of strokes per minute; divide this by 0.7854. The square root of the result will be the diameter of the water piston required. It is good practice to operate a feed pump slowly, and running at its normal speed it should be capable of supplying double the average requirements.

Clearance and Mean Effective Pressure

What effect has clearance on the mean effective pressure?

C. M. P.

For a cutoff at any fraction of the stroke, the greater the clearance the higher the mean effective pressure will be.

Heat Required to Convert Ice into Steam

A block of ice weighs 10 pounds, and has a temperature of 18 degrees Fahrenheit. Compute the amount of heat required to convert it into steam having an absolute pressure of 30 pounds.

S. C. S.

To raise the temperature of one pound of ice from 18 to 32 degrees requires 7 heat units; to convert it from ice at 32 degrees into water at 32 degrees requires 142 heat units and to convert it into steam at a pressure of 30 pounds absolute requires 1158 heat units. Adding

$7 + 142 + 1158 = 1307$ *heat units.*

Ten pounds will require 10 times this.

Utility of Expansion Tank

Of what use is an expansion tank in a hot-water heating system?

U. E. T.

Like all other substances, water varies in volume with changes of temperature and the expansion tank placed at the highest point in the system furnishes room for the increase of volume of water in the boiler, piping and radiators as it is heated.

Size of Steam Pipe

How can I determine the proper size of steam pipe to supply a given size of cylinder?

S. S. P.

Multiply the cross-sectional area of the cylinder by the speed of piston travel in feet per minute and divide the product by 6000.

$$\frac{\text{Piston area} \times \text{piston speed}}{6000} = \text{Pipe area}$$

Ratio of Expansion by Volume

In a 12x18-inch engine the clearance is 5 per cent. Cutoff takes place when the piston is 6 inches from the end of the stroke. What is the real cutoff and what is the ratio of expansion by volume?

S. S. C.

The distance swept through by the piston is 18 inches, 5 per cent. of which is 0.9 inch; this makes a total cylinder length of 18.9 inches. If the cutoff takes place at 12 inches of the piston stroke the real cutoff will be $\frac{12.9}{18.9}$ of the cylinder volume, and as the ratio of expansion by volume is the final volume divided by the volume at cutoff. The volume at cutoff in this case is proportional to 12.9 and the final volume to 18.9. Hence the ratio of expansion is

$$18.9 \div 12.9 = 1.46.$$

Power Required to Drive Vessel

If 4000 horsepower will drive a vessel at a speed of 14 knots, how fast will 2000 horsepower drive the same vessel?

P. R. D.

The power required to drive a vessel is proportional to the cube of the speed, and inversely the speed will be proportional to the cube root of the power expended; hence,

$$\sqrt[3]{4000} : \sqrt[3]{2000} :: 14 : S$$

$$\sqrt[3]{4000} = 15.8 \quad \sqrt[3]{2000} = 12.6$$

then

$$15.8 : 12.6 :: 14 : S.$$

$$S = (12.6 \times 14) \div 15.8 = 11.$$

If 4000 horsepower will drive the vessel 14 knots, 2000 horsepower will drive the same vessel 11 knots.

Diameter of Pipe for Given Flow

What will be the diameter of a pipe 150 feet long which will deliver 600 pounds of steam per hour with a pressure drop of 5 pounds, the boiler pressure being 75 pounds?

P. G. F.

A much used formula for the flow of steam in pipes is,

$$W = 56.68 \sqrt{\frac{w\,(p_1 - p_2)\,d^5}{L}}$$

in which

W = Weight of steam flowing per minute;

w = Weight of 1 cubic foot of steam at higher pressure;

$p_1 - p_2$ = Drop in pressure;

d = Diameter of pipe in inches;

L = Length of pipe in feet.

Substituting the known values,

$$10 = 56.68 \sqrt{\frac{0.2044 \times 5 \times d^5}{150}}$$

$$100 = \frac{3220 \times 0.2044 \times 5 \times d^5}{150}$$

$$d^5 = \frac{100 \times 150}{3220 \times 0.2044 \times 5} = 4.55$$

$$d = 1.35 \text{ inches}$$

As there is no pipe made in this size, 1½-inch pipe will be required.

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Contents

PAGE

Modern Boiler Plant, Holyoke, Mass.... 254
Central Station vs. Factory Plant..... 260
Loaded Safety Valve..... 261
Piping Layout of Closed Heaters..... 262
Exhaust Steam Turbines in England.... 263
Firing Boilers with Pulverized Coal..... 264
Jones; Trouble Killer..... 268
The Melville-Macalpine Gear for Direct-Current Generators..... 270
Steam Heated Flume Racks for Hydraulic Plants 270
Erratic Belt Behavior..... 270
A Cranky Induction Motor..... 270
Long Stroke and Short Stroke Engines.. 271
Mr. Booth's Gasket and Mr. Sanders' Cracked Jacket..... 273
Practical Letters:
Making Pipe Covering....Don't Neglect the Safety Stop....An Oil Trap....How to Use a Pipe Wrench ....Exhaust Head Too Small.... Governor Arm Broke....Pipe Clamps....Homemade Tube Cleaner ....Getting the Position "Higher Up"....Federal Laws....Removing Oil from the Eye....Fitting Piston Rings....Water in the Turbine.... Homemade Babbitt and Belt Dressing 274-276
Discussion Letters:
Setting Horizontal Tubular Boilers ....Troubles of a Refrigerating Engineer....Hotel Power Costs.... Placing the Responsibility....Air Pressure for Lifting Water....Graft ....Experience of an Indicator Man ....Effects of Cold Air....Pittsfield Boiler Explosion....Cause of Boiler Explosions....."Something Just as Good"....Metallic Packing ....The Engineer's Education...277-281
Editorials 283-284
Falling Stack Kills Engineer..... 285
Latest Design of Straight-flow Engine... 285
Oldest High-pressure Steam Engine..... 286
Capacity of Absorption Machines..... 287
Steam Turbine Economy in Europe..... 288

POWER

The Engineer and the Machine

Through many channels the field of the operating engineer is being invaded and with a success that depends entirely upon the alertness of the particular engineer whose plant is selected by the outsider as a possible source of revenue. The lubricating engineer, the supervising engineer and the emissary from the central station are all looking for business and the isolated plant is the land of promise they seek to exploit.

So great has been the improvement in machinery designed to displace or render needless the skill of the human hand and brain that whole trades have disappeared and armies of skilled hand workers have been reduced to the ranks of common laborers, tenders of machines, etc.

In the supervising engineer one form of the machine idea manifests itself, for in one individual is all the skill considered necessary for the economical operation of several plants, the routine work being done by rote by the commonest labor, which costs so much less than skilled labor that the payroll shows quite a decrease after deducting the fees of the peripatetic supervisor.

In the lubricating engineer the machine idea takes another form. Claiming to have saved a large percentage of the fuel used in this or that plant by intelligent lubrication. The fuel buyer's ear is readily gained and the skill of the engineer as a user of oil is rendered useless if the professional oiler gets a foothold and makes good. A cheaper man will do the oiling in the future.

But the greatest menace the engineer faces is the central station, which with its lines reaches to the limits of human habitation and industries. It stands ready to displace the engine with a motor that will run for months or years without either oil or supervision and may be started or stopped by pushing a button in any convenient location.

It is the engineer's problem to prove that it is cheaper for the power user to buy his skill than the partially or wholly machine substitute. Power generation and transmission is the field in which the special skill of the engineer is required and it depends upon his alertness or inertia whether he holds the field to himself, shares it with another at a reduced wage or is forced out altogether with no wage at all. The man in charge of a power plant, whether large or small, is directly the determining factor in the economy of its operation, and he should know more about every detail of this operation than is possible for any outsider, however well equipped he may be.

Successful steam engineering requires special training and special knowledge along several lines. Special knowledge comes only from special application. The engineer has in his own plant, small and unimportant though it may be, better facilities for special study of his own conditions than any other man in the world and he must use them to the limit of his ability or be displaced by some one of the many forms of skill-supplanting machines, human or mechanical, and take his place with the workless workers of other excluded trades.

Milwaukee Garbage Destructor

In the December 7 issue of the *Municipal Journal and Engineer,* there appears a statement attributed to H. E. Briggs, commissioner of public works, of Milwaukee, which, if true, would constitute a severe arraignment of Milwaukee's new garbage destructor, some test figures from which were given in our issue for November 29. The statement is to the effect that it is costing the city of Milwaukee two dollars and eighty-five cents per ton to dispose of garbage at the new plant, when, as a matter of fact, this figure includes not only the cost of incineration but also of collecting the garbage. Of the total cost of two dollars and eighty-five cents, therefore, not more than approximately eighty-five cents can be charged to incineration, the remainder of the charge being for hauling and labor incidental to the delivery of garbage at the plant. When the conditions of the test as reported in POWER are understood it is easy to see how the cost is divided. The specifications called for a test run, to include only the actual operation of the fire, stoking, etc., and keeping the grates clear of ash and clinker. The test was not to include the items of supervision, hoisting, weighing, conveying, disposing of ash and clinker, or repairs; as it was assumed that these items would be the same for any system of disposal and could therefore be eliminated. The percentage of garbage is the greatest fac-

tor in the cost of operation and the test figures were obtained when using forty-one per cent. of this constituent. At the present time the everyday cost of operation is somewhat higher than the figures given in the test, by reason of the fact that the condition of the garbage and refuse as delivered to the plant varies with the season of the year, and from fifty-five to sixty per cent. of garbage is now being incinerated. Also the pay of a fireman has increased from two dollars to two dollars and fifty cents per eight-hour day.

In the *Journal* of Associated Engineering Societies, for December, S. A. Greeley, superintendent of the plant, gives the cost figures for the first five months of its operation, the cost ranging from eighty-two cents to one dollar and seven cents per ton. According to these figures the average amount of material disposed of per day was one hundred and ninety-four tons; the average percentage of garbage was sixty-six; the percentage of ash was twenty; of rubbish, eleven, and manure, three; while the average cost of disposal during this period is given as ninety-five cents per ton. For the month of November, 1910, the cost was seventy-eight cents per ton.

There is one interesting feature of this installation which has not been touched on and which will throw considerable light on the management of municipally operated institutions. Some months ago, in the effort to economize in operation, the labor expense for the plant was reduced to such an extent as to cut the expense for disposal of refuse per ton from eighty-eight cents to seventy-eight cents. This was unsatisfactory to the labor organizations and the city administration ruled that the men should be reinstated. Whenever a municipally operated project is proposed the cry goes up that on account of the high wages and short hours commonly associated with such institutions the project cannot compete with a privately operated plant. Here we have an example of a municipally operated property run by a Socialist administration which is extremely friendly to union labor and where the difference in labor cost between satisfied and dissatisfied union workers represents roughly only twelve per cent. of the total cost of operation.

Smoke and Health

At a meeting of the Engineers' Club of Philadelphia, a short time ago, at which the subject of smoke prevention was discussed, an eminent physician made the following statement:

"Is it any wonder that respiratory diseases and diseases of the mucous membranes are so common and habitual in our big cities, where railway and factories daily pour forth volumes of black smoke? Sore eyes and catarrh of the nose, throat and bronchial passages may be produced directly by the mechanical irritation of smoke particles. Smoke does not produce tuberculosis. The infective agent of this disease is carried in dust. However, the smoke evil, if not a direct producer, is indirectly an important and serious predisposer to the disease. This happens in two ways: First, by a local irritation of the membrane of the air passages it sets up a catarrhal susceptibility to infection; secondly, by the habitual catarrhs and insufficient quantity of fresh air so contaminated by smoke the general systematic resistance to disease is diminished, and when the recuperative and reparative powers of the body are thus debilitated and weakened, the bacillus soon finds favorable soil and lodgment, and ready access to the vulnerable tissues."

So much for the injurious effect of smoke, but how about the sulphurous gases with which the air of large cities is contaminated due to the burning of coals high in volatile sulphur?

President Taft's Water Power Policy

On February 1, President Taft approved a plan for the leasing by the Government of water-power sites on public lands. The essential features are that the Federal Government shall continue to own and control the water powers on the public domain. Legislative authority must be sought for issuing term leases for periods not to exceed fifty years. Those leasing from the Government must pay for what they get and must promptly and fully develop the powers so that there shall be no unnecessary limitation of output. Rates to consumers declared exorbitant by the Supreme Court shall be ground for the cancelation of the lease. At the expiration of the lease, it is proposed to give the lessee a preference right to renewal unless the Government desires to use the property for public purposes; and, provided the lessee fails to secure a renewal either because the Government desires the land or because another applicant offers better terms, the previous lessee shall receive compensation for the actual value of improvements on the ground or be allowed to remove such equipment.

As president of the National Conservation Association, Gifford Pinchot highly commends President Taft's water-power policy. It is in full accord with the principles for which the association stands, and the policy as outlined has been enforced by the United States Forest Service so far as the existing law would permit.

The rigid enforcement of this policy will mean a great deal to the country. It will prevent a monopoly in water power, tend to keep the rates for power at a reasonable figure, and above all keep the water powers in the hands of the people. It should be enacted by legislators, rigidly enforced by employees of the Government and supported by the people.

The Isolated Plant Association

The motto "In union there is strength," seems to be the keynote of the present movement to resist the encroachment of the central station on the field of the isolated plant. It is not alone the engineer who feels the ground slipping from under him; the manufacturer, the salesman and everyone even remotely concerned with them, feel the pinch that is to come when but one public-service corporation shall furnish all the power required in a community. Accordingly these various interests have united in an organization known as the National Isolated Plant Association.

As is the case with all such organizations its success or failure will depend largely upon its policy at the start. It must gain the confidence and coöperation of all parties concerned, and in order to do this it must be manifest, both in words and action, that the common interest alone is to be served.

Little will be gained by adopting a hostile attitude toward the central station, but much progress can be made by proceeding along competitive lines, based upon actual knowledge of the facts. It must be conceded that there are a few classes of service wherein the central station can legitimately furnish power cheaper than the isolated plant, and it should be the policy of this organization to show the consumer just where the line should be drawn. In short, its duty will be to seek the truth, even though the shoe may pinch in certain instances.

In his annual report, Pres. Henry M. Whitney, of the Rhode Island Coal Company, made the following statement: "The coal is of excellent quality, and the so called 'treatment' has been found to be unnecessary, since the coal burns as well without as with it." Over a year ago POWER gave some little attention to Rhode Island coal and we are glad to see that Mr. Whitney's present opinion concerning the value of the treatment verifies our prediction.

According to reports of the United States Geological Survey, California contains approximately one-tenth of the total oil-producing territory in the United States. Yet it is estimated that she furnishes one-half the probable minimum and one-third the probable maximum oil production of this country.

Some engineers imagine that because they have kept a small power plant running, they can handle a large central station.

Falling Stack Kills Engineer

During a high wind that swept over New Jersey, Saturday, January 25, a 90-foot brick stack at the Caledonian mill of the United Box Board Company, Whippany, N. J., was blown down, instantly killing the engineer, George Lockwood, and severely injuring Superintendent William Purcell.

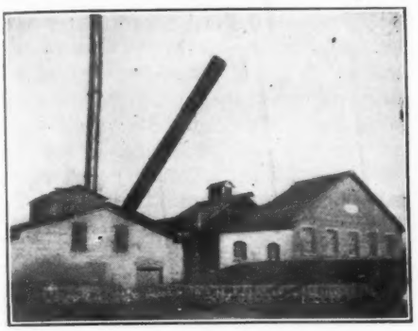


FIG. 1. TILTED IRON STACK

The stack stood at one end of the boiler house and served one of three return-tubular boilers. The other two boilers were each served by a separate 60-foot iron stack. When the brick stack collapsed, it parted the guy wires of one of the iron stacks, causing it to tilt over as shown in Fig. 1.

In falling, the brick stack crashed diagonally through the engine-room roof and that of the stock room of the main building. It was in this latter room that Lockwood was killed. Fig. 3 shows the crumbled condition of the base of the chimney and the wreck of the buildings. Most of the chimney fell into the engine and stock rooms, partially wrecking the engine and other apparatus. Fig. 2 shows a partial view of these rooms after much of the débris had been removed.

Lockwood was found pinned under an 8x12-inch timber which had supported the roof and it was this same timber that partly protected the superintendent, who is expected to recover,

This stack was erected about fifty years ago. It was recently repaired, but according to the consensus of opinion the stack was unstable at the corner next to the mill, where the brick had weakened with age. This and the high wind were sufficient to cause the disaster. From the appearance of the brick débris, the base of the stack collapsed, allowing the upper part to settle, and, then losing its equilibrium, to topple over onto the roof of the building.

Men were set to work cleaning away the wreckage and a good deal of the stack had been removed before a POWER representative could get to the scene of the accident.

A report that seems to be borne out by the evidence is to the effect that the chimney had been considered unsafe for some time, and that the engineer, becoming anxious about it in the high wind, looked up the superintendent, and that both men were on their way to the boiler room when the crash occurred.

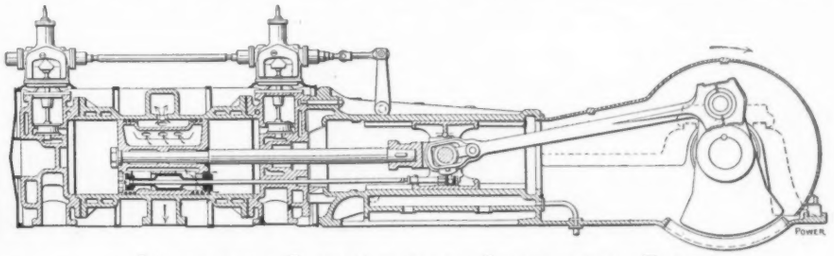
FIG. 2. ENGINE AND STOCK ROOMS

FIG. 3. CRUMBLED STACK BASE AND WRECKED WALL

The're buildin' Lock 26 on the Ohio river near Gallipolis, an' the other day I got a picture postal from there showing the "Coffee Dam" an' the battery of bilers for makin' er. Now I wonder what brand of coffee'd be strong enough to dam the Ohio?

Latest Design of Straight Flow Engine

In the article by Rulof Klein on the straight-flow engine, which appeared in the January 31 issue of POWER, reference was made to Fig. 5 as the latest design of noncondensing straight-flow engine. A cross-section of a condensing engine



LONGITUDINAL SECTION THROUGH STRAIGHT-FLOW ENGINE

designed for connection to a jet condenser was inadvertently substituted for the accompanying illustration. Mr. Klein's description was as follows:

The latest design of noncondensing straight-flow steam engine, which bears witness of the resourcefulness of the inventor, is shown in Fig. 5. A piston valve is placed inside the piston directly below the rod. It is operated by a little rocker arm, which is attached to the crosshead end of the connecting rod, and rocks about the crosshead pin as center. The valve alternately opens one side of the piston or the other to the respective cylinder ends, procuring passage for the exhaust steam from these ends through its seat and the holes in the side of the piston to the exhaust slots. These valves close a trifle after the exhaust slots are closed by the second set of piston rings passing them. Pressure inside the piston is kept atmospheric throughout the stroke.

The third paragraph from the end of the article should have contained the word balancing, as this is the feature referred to.

Oldest High Pressure Steam Engine

By B. M. Baxter

This engine, which was without doubt the first of the high-pressure early cutoff type, was built by Oliver Evans at Philadelphia in 1801. It is still in good condition and at present is the property of the University of Pennsylvania.

A steam engine, which bears the date of 1801, and probably antedates any other of its kind built on this side of the Atlantic, is to be found at the mechanical-engineering laboratories of the University of Pennsylvania. It is complete in every respect with the exception of the flywheel and could be put into running order with very little trouble.

The engine, as shown in Fig. 1, is of the vertical-beam type, sometimes called the "grasshopper" type, and has a 12-inch cylinder and a 20-inch stroke. The slide valve is driven from an eccentric on the main shaft, through a rocker arm and shaft and vertical side rods attached to a yoke which, in turn, is connected to a vertical valve stem. In Fig. 2 this valve gear is clearly shown.

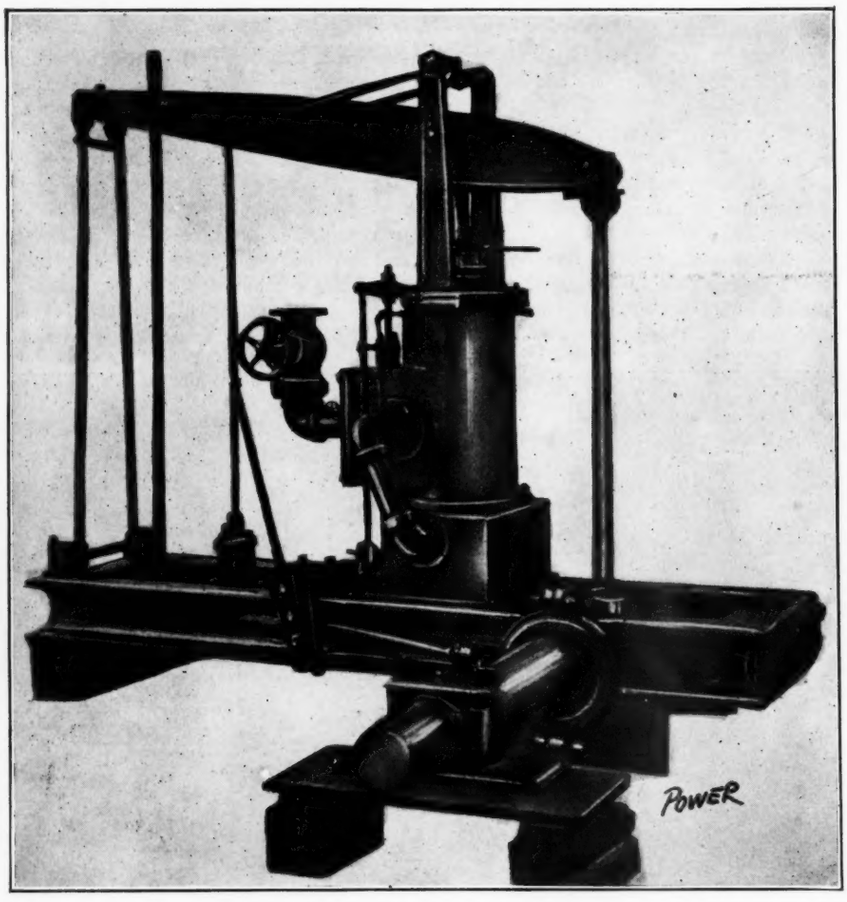


FIG. 1. GENERAL VIEW OF ENGINE

The crank is of the overhung type, and all the rod ends are strap ended with gib and key adjustment, similar to that used on many engines of modern design. The vertical rod attached to the beam, to the left of the cylinder, operates a plunger pump, which was probably used for the boiler feed. The discharge pipe from the pump projects vertically upward near the end of the frame.

There are two brass plates attached to the beam, which bear the following inscription:

OLIVER EVANS
1801

The inscription on a third plate, apparently of great age, is not legible, and another one of more recent date reads:

PRESENTED BY THE WILLIAM CRAMP & SONS SHIP AND ENGINE BUILDING COMPANY TO THE UNIVERSITY OF PENNSYLVANIA.

This engine is of the high-pressure, cutoff type, in contrast to the Newcomen or Watt engines which used steam merely as a means of producing a vacuum, the atmospheric pressure doing the work.

Oliver Evans has a good claim to being the inventor of the cutoff engine, the principles of which are outlined in his book entitled, "The Abortion of the Young Steam Engineers' Guide," which was published in Philadelphia in 1805. Quoting from this work, regarding this type of engine, he says, "Although the inventor had obtained a patent in the State of Maryland, he was so engaged with the introduction of his mill improvements that he could not prosecute his inventions on steam engines, further than filing drawings and specifications of the principles in the patent office in 1792, and trying some experiments which confirmed him in the principles. In the year 1801 he commenced the execution of an engine and in the winter of 1802 had it in full operation." This extract relates to the use of high-pressure steam with early cutoff, pressures of 120 pounds per square inch being mentioned elsewhere in the book.

The Use of Crude Petroleum as Fuel

At a recent meeting of the San Francisco branch of the American Society of Mechanical Engineers, a number of papers were presented upon the subject of oil fuel. In a paper entitled the "Relative Heat Value of Light Oil as Compared with Heavy Oil," Professor Le Conte stated that crude petroleum consists principally of hydrogen and carbon together with small amounts of nitrogen, oxygen and sulphur. The nitrogen and oxygen and any incombustible residue or ash may be classed as inert impurities, while the sulphur, although a combustible, has a low heat value and is otherwise injurious.

The oils rich in hydrogen are of light specific gravity as compared with those rich in carbon; also, the former contain more heat units per pound than the latter. Water in emulsion in crude oil acts as an inert impurity and as it must be converted into steam it reduces the heat value. From the tests of a number of samples of the heavier fuel oils, it was shown that the heat value increases inversely as the specific gravity, but does not increase so rapidly as the weight per unit of volume decreases. Therefore, the heat value per barrel of the heavier oils is greater than that of the lighter ones.

Mr. Weymouth, in a paper upon "The Arrangement of Furnace for Using Oil Fuel," described the Peabody furnace. In this the bridgewall is set back from the boiler front 8 to 10 feet, with the

burner of the back-shot type, inserted from the boiler front under the furnace floor and turning up at the bridgewall, without there being any direct impingement of flame. With this design of furnace a boiler efficiency of 83 per cent. has been attained. The paper further stated that when admitting a large excess of air and an average amount of oil, the flame length is a minimum and the temperature of incandescence is reached at the surface of the envelope separating the vaporized oil and air. This bright flame is sought by the untrained fireman, but it results in a loss of heat, as the subsequent mixture of the products of combustion with the excess of air, not in contact with the flame, means a lower mean furnace temperature. With economical firing the flame lengthens before coming in contact with sufficient air for complete combustion, and with the highest furnace efficiency this temperature varies from 2500 to 2800 degrees Fahrenheit.

Due to the high furnace temperature with oil fuel the location of the heat-absorbing surfaces becomes of utmost importance; consequently the first pass should be located directly over the furnace, thus providing for the most direct transmission of heat, both by convection and the absorption of radiant heat.

A paper on "The Size of Stacks with Oil Fuel," by Mr. Dunn, called attention to the fact that in burning coal a large part of the total draft (from 35 to 70 per cent.) is required to overcome the friction through the fuel bed. This is done away with in burning oil fuel, consequently a shorter stack may be used; a stack of 80 to 100 feet in hight usually being sufficient.

An interesting paper upon the "Atomization of Oil Fuel" was read by Mr. Hunt. This was in part as follows:

General practice is to deliver the oil to the burner under pressure, and inject and atomize it, using either steam or air as the atomizing medium. The oil injected into the furnace should be entirely gasified or burned while in suspension in the air; otherwise, if particles of unconsumed oil fall to the bottom of the furnace, coke will accumulate. If the oil is injected into a cold furnace not inclosed by brick walls which become highly heated, it must be in the form of a fine spray. But if the walls are highly heated, the radiation from them will aid greatly in vaporizing the particles of oil and the larger particles will be consumed before they drop.

Most of the oils used for fuel are of a heavy and viscous character and their viscosity is reduced by a rise in temperature. Therefore, it is desirable that the oil be preheated before being fed to the burners. The form of burner is of small importance compared with the furnace construction, proper air supply, etc.

Some work has been done toward atomizing the oil without the use of air or steam. The oil, having been preheated to 220 to 260 degrees Fahrenheit, is injected into the furnace through a needle nozzle having a small orifice. The portion of the needle stem inside the cylindrical part of the nozzle has a screw thread cut on it, which imparts a rotary motion to the oil. The sudden release of pressure and the rotary motion cause the heated oil to issue in the form of a spray sufficiently fine to burn successfully.

From a number of tests, using steam as an atomizing agent, the amount of steam varied from 2.5 to 5.7 per cent. of the total evaporation. It may be said, however, that in designing a plant it is safe to assume 5 per cent. of the evaporation of the boilers as the steam necessary to operate the burners; but, if this exceeds 3 per cent. in actual operation, it may be concluded that conditions may be bettered.

Except in special cases, the use of compressed air as the atomizing agent may be said to offer no opportunity for a saving in fuel over the use of steam.

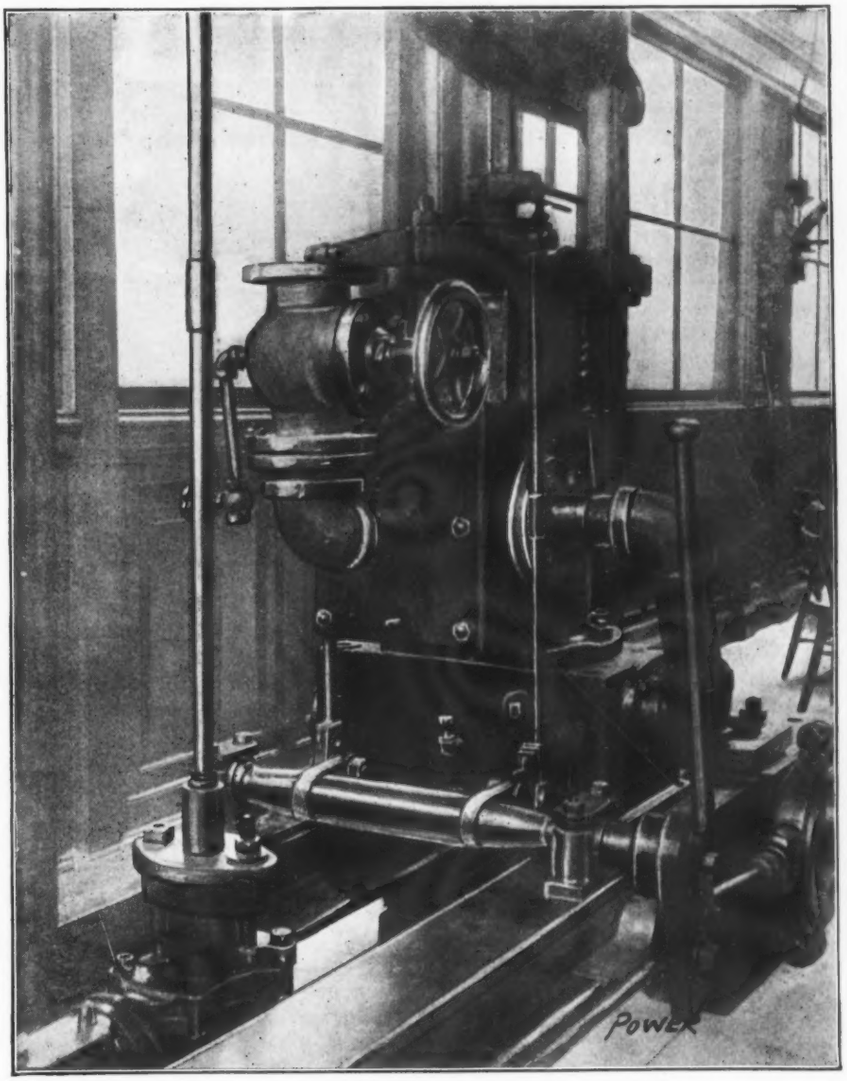


FIG. 2. VIEW SHOWING VALVE GEAR

Capacity of Absorption Machines

BY F. E. MATTHEWS

The capacity of an absorption, like that of a compression, ice machine can be estimated by two different methods, either by determining the amount of anhydrous ammonia made in a given length of time or by finding the amount of cooling effect actually produced on brine.

Since the so called "anhydrous" ammonia entering the receiver of an absorption machine is often far from free of water, the latter method is to be preferred.

For very rough estimates of the capacity of a machine a cooling effect equivalent to that of five gallons of brine cooled through five degrees Fahrenheit per minute, or what is sometimes known as 25 "heat gallons," is considered a ton.

Since the amount of refrigeration required to cool brine, or, in fact, any other substance, depends on the specific heat

of the substance as well as on the amount chilled in a given time and the range of temperature chilled through, it is obvious that careful determinations of the specific heat of the brine should be made where accurate results are expected.

Specific heats taken from tables of properties of the kind of brine being used and corresponding to the density of the brine in use as determined by a hydrometer—due correction being made for temperatures—should give fairly accurate results.

If an absorption machine is operating on zero brine, calcium would ordinarily be used. In order to just escape freezing at this temperature, its density would have to be 22 degrees Baumé, corresponding to a specific gravity of 1.179. The specific heat of brine of this strength is 0.834. As a matter of fact, for safety against freezing, a somewhat stronger brine should be used, common practice being to use about 24 degrees Baumé, the specific heat of which is 0.817.

For every pound of brine of this quality cooled, one degree 0.817 B.t.u. of cooling effect is required.

To determine the refrigerating effect being produced, determine the amount of brine, in pounds, being chilled in a given length of time; determine also the range in temperature chilled through. Multiply the number of pounds by the range in temperature giving "pound degrees" and then by the specific heat giving B.t.u.

A ton of refrigeration is the equivalent of the heat absorbed in the melting of 2000 pounds of ice having a latent heat of fusion of 144 B.t.u.; that is, 288,000 B.t.u. The expenditure of cooling effect equivalent to the above per 24 hours is a ton of capacity.

Since there are 24 hours in a day, a ton capacity is also equal to the absorption of 1200 B.t.u. per hour; and since there are 1440 minutes in a day, it is also equal to the absorption of 200 B.t.u. per minute.

To arrive at the tonnage capacity of the machine under test, divide the number of B.t.u. of cooling effect produced on the brine per minute by 200, or the number per hour by 1200, or the number per day by 288,000.

The quantity of brine cooled can be arrived at roughly by the use of a meter, still more roughly from the size and number of strokes of the brine pump; but actual weighing is to be recommended where great accuracy is required.

One cubic foot of water at 62 degrees Fahrenheit weighs 62.355 pounds, and one gallon 8.336 pounds. To get the weight of brine of any density per cubic foot or per gallon, multiply these weights by the specific gravity of the brine determined at the same temperature.

If the brine has a strength of 24 degrees Baumé, for example, equivalent to a specific gravity of 1.2, the weight per gallon will be

$$1.2 \times 8.336 = 10 \textit{ pounds.}$$

With brine of these characteristics, the cooling of five gallons through five degrees, making 25 heat gallons per minute, would represent a cooling effect of

$$\frac{10 \times 5 \times 5 \times 0.817}{200} = 1.021$$

tons per 24 hours.

TABLE OF PROPERTIES OF SALT (NaCl) AND CALCIUM (CaCl) BRINES.

Sodium Chloride (Salt) Brine.			Calcium Chloride Brine.		
Degrees Baume.	Specific Gravity.	Specific Heat.	Degrees Baume.	Specific Gravity.	Specific Heat.
1	1.007	0.992	3	1.027	0.980
2	1.015	0.984	6	1.041	0.964
3	1.019	0.980	9	1.058	0.936
3.5	1.023	0.976	10	1.076	0.911
4	1.026	0.972	11	1.085	0.896
4.5	1.030	0.968	13	1.103	0.884
5.5	1.037	0.960	15	1.121	0.868
6.5	1.045	0.946	20	1.159	0.844
7.6	1.053	0.932	22	1.179	0.834
8.7	1.061	0.919	24	1.199	0.817
9.7	1.068	0.905	26	1.219	0.799
10.7	1.076	0.892	28	1.240	0.778
12.6	1.091	0.874	34	1.305	
15.7	1.115	0.855			
20.4	1.155	0.829			
24	1.187	0.795			
25	1.196	0.783			
25.8	1.204	0.771			

Steam Turbine Economy in Europe

Interesting results of recent turbine practice in Europe are given in the accompanying table, reproduced from the *Zeitschrift des Vereines Deutscher Ingenieur*, of December 10. The values have been converted into English units.

EUROPEAN TURBINE TESTS.

Type of Turbine.	Manufacturer.	Rated Capacity, Kw.	Steam Pressure, Pounds Absolute.	Superheat, Degrees Fahrenheit.	Vacuum.		Steam Consumption, Pounds per Kw.-hour.	B.t.u. per Kw.-minute.	Steam Consumption, Pounds per Kw.-hour. Load.		
					Inches of Mercury.	Pressure, Pounds Absolute.			¾	½	¼
Parsons	Brown, Boveri & Co	3500	162	134	28.7	0.55	13.7	290	.....	.....	.....
Lindmark	Laval Gesellschaft	1500	187	167	28.3	0.75	16.7	343	.....	.....	.....
Rateau	Oerlikon	488	176.5	130	27.5	1.13	18.6	369	19.42	21.57	25.84
Zoelly	F. Ringhoffer	3000	176.5	99	27.5	1.17	15.5	320	16.24	17.89	19.89
Zoelly	Escher, Wyss & Co	5000	172	167	26.2	1.79	16.12	321	.....	.....	.....
Zoelly	Masch. Fabr., Augsb., Nürnb'g	1400	187	178	27.4	1.28	14.2	286	.....	16.61	20.32
Zoelly	Masch. Fabr., Augsb., Nürnb'g	1250	188	205	28.75	0.56	13.05	268	13.97	15.40	.....
M & PF	Breitfeld, Danek & Co	430	162	220	28.2	0.85	17.8	374	18.34	20.37	24.92
M & PF	Breitfeld, Danek & Co	3585	167	91	28.25	0.81	16.05	344	16.44	17.50	20.33
M & PF	Melms & Pfenninger, G. m. b. H. (Limited).	1000	196	259	28.0	1.03	15.65	329	.....	.....	.....
M & PF		1000	193	212	28.5	0.70	15.19	316	.....	.....	.....
Zvonicek	Boehm. Maehr. Masch. Fabrik, Prague.	710	165	129	26.2	1.86	19.2	376	.....	.....	.....
Zvonicek		3167	164	107	28.5	0.69	14.72	294	.....	16.39	.....
A. E. G. Curtis	Allgem. Elektr. Gesellschaft, Berlin.	2236	198	272	29.25	0.29	11.75	275	11.98	12.98	14.45
A. E. G. Curtis		3000	198	210	29.00	0.43	12.79	273	12.99	13.98	15.28
B. B. & Co.	Brown, Boveri & Co	500	155	212	28.5	0.73	16.29	337	17.26	18.49	23.79
B. B. & Co.	Brown, Boveri & Co	1100	191	194	28.5	0.73	14.72	306	15.16	16.50	19.44
Masch. Fab., Augsb.	Maschinen Fabrik, Augsburg	1250	188	205	28.7	0.56	13.05	273	13.95	15.33	.....
Masch. Fab., Augsb.	Maschinen Fabrik, Augsburg	700	145	217	29.0	0.47	13.58	308	14.05	15.48	19.83
Curtis	British Thomp. Houston	2500	131	66	28.5	0.73	15.88	309	.....	.....	.....
B.E.W.	Bergmann Electr. Werke	1545	195	202	28.4	0.68	12.92	270	13.30	14.73	.....
B.E.W.	Bergmann Electr. Werke	292	157	232	27.25	1.03	18.85	391	19.64	22.25	.....
B.E.W.	Bergmann Electr. Werke	556	204	63	28.5	0.73	17.38	341	17.49	20.5	25.73
B.E.W.	Bergmann Electr. Werke	702	17	Exhau't	26.9	1.47	33.90	605	36.38	41.68	.....
E.B.M.	Erste Bruenner Masch. Fabr.	650	176	57	27.5	1.18	18.72	360	.....	20.22	.....
E.B.M.	Erste Bruenner Masch. Fabr.	1250	191	206	27.7	1.03	14.3	294	.....	16.44	.....
E.B.M.	Erste Bruenner Masch. Fabr.	6000	191	206	28.2	0.87	12.75	265	.....	13.90	.....
E.B.M.	Erste Bruenner Masch. Fabr.	225	18	44	27.5	1.18	39.4	722	.....	47.7	.....
E.B.M.	Erste Bruenner Masch. Fabr.	200	206	188	.....	58	50.5	965	.....	58.1	.....
E.B.M.	Erste Bruenner Masch. Fabr.	1100	191	194	.....	22	30.5	562	.....	39.08	.....
E.B.M.	Erste Bruenner Masch. Fabr.	2000	160	119	27.5	1.03	13.72	284	.....	.....	.....

The National Isolated Plant Association

At a meeting of the National Isolated Plant Association, held at the Engineering Societies' building on Monday evening, January 30, a constitution was adopted and the permanent officers elected. These were as follows:

President: C. G. Armstrong, consulting engineer for the city of New York.

Vice-president: F. E. Stiles, chief engineer of the West Street building.

Secretary: E. D. Fieux, of the Wing Manufacturing Company.

Treasurer: W. B. Elliott, of the Garwood Electric Company.

Council: Mr. Buxton, operating engineer; Mr. Kimball, consulting engineer; Mr. Ferguson, manufacturer; Mr. Katten, salesman; Mr. Elliman, plant owner. The president and treasurer are *ex officio* members of the council.

Committee on admission of members is made up of the following members: Mr. Dalbec, operating engineer of the Patten estate; Mr. Wing, of the Gotham Manufacturing Company; Mr. Torrence, of the Carbondale Machine Company; Mr. Spooner, of the Ridgway Dynamo and Engine Company; Mr. Edgerton, constructing engineer; Mr. Bierck, of Borne Scrymses Company, and Mr. DeGress, of the Crocker-Wheeler Company.

Except in the case of the operating engineers actually engaged in the direction or operation of isolated plants, the initiation fee for members is $15 and the annual dues $10. No initiation fee is charged the operating engineer and his dues are $2 per year. Candidates for membership must be proposed by two members, who shall submit to the committee on admissions full particulars regarding the business and qualifications of the candidate.

As yet a complete program of procedure has not been decided upon, but it is planned to make complete tests upon numerous isolated plants now in operation with a view to collecting cost data for the enlightenment of the owner against the encroachment of the central-station solicitor.

PERSONAL

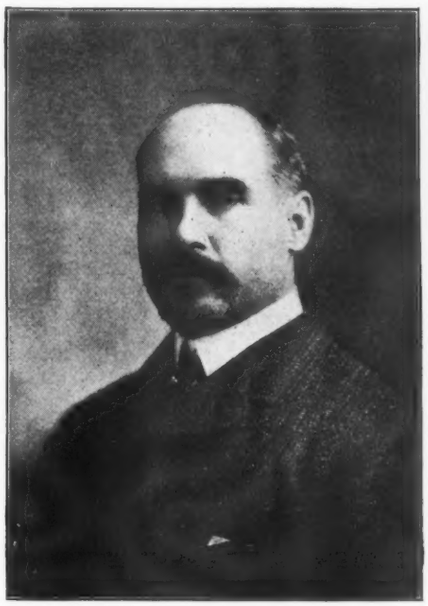
C. A. Tupper, of the Alliance Engineering and Sales Company, Inc., Milwaukee, has sailed for a cruise among Mediterranean ports and a trip through the greater part of Europe in behalf of various manufacturing interests. He is accompanied by his wife and son.

S. F. Jeter has resigned as mechanical engineer for the Bigelow Company, of New Haven, Conn., to accept the position of supervising inspector for the Hartford Steam Boiler Inspection and Insurance Company. With the exception of a short period of time, Mr. Jeter was in the employ of this company from 1898 to 1906, first as inspector and then as special agent. He will be recognized as the author of numerous valuable contributions to our reading columns.

OBITUARY

Louis R. Alberger

Louis R. Alberger, president of the Alberger Condenser Company, died in New York City on January 31. He was born in Buffalo in 1864 and, after leaving high school, entered Yale, but later left to enter business with his father, who was engaged in the vacuum process of producing salt. In 1887 he went with Henry L. Worthington, where he remained until 1901, leaving to form the Alberger



LOUIS R. ALBERGER

Condenser Company and the Alberger Pump Company, both of which he became president of. The interment was held in Buffalo on February 3.

William B. Mason

William B. Mason, president of the Mason Regulator Company, and inventor of numerous valve and engine appliances, died at his home in Dorchester Lower Mills, Mass., on Saturday morning, February 4. He had been ill for some time, the last four weeks of which he was confined to his house.

He was born in Freeport, Me., and at an early age went to work in the Grand Trunk machine shops, where he learned the trade of machinist. Coming to Boston as a young man, he worked on stationary and marine engines, and as an engineer on harbor tugs. He joined the navy as a machinist, and was assigned to the U. S. S. "Omaha," serving for two years on the Pacific station.

Returning to Boston, he entered the employ of Cressey & Noyes, and here perfected his first invention, a governing

WILLIAM B. MASON

regulator. Soon after this he produced the reducing valve now in use on three-fourths of the locomotives in this country, a device which permits the heating of cars. In 1883 he joined the company, of which he was the head, for the manufacture of his devices.

At his factory was built the first automobile steam engine used by the Stanley Motor Carriage Company, and subsequently between 5000 and 6000 automobile engines were turned out. He remained active in the conduct of his business until a few weeks ago.

Mr. Mason was a member of the American Society of Mechanical Engineers, and also of the New England Railroad Club. He is survived by a widow, and one daughter, Mrs. Eva Maybery, of Brunswick, Me.

NEW PUBLICATIONS

AN INTRODUCTION TO THERMODYNAMICS. By John Mills. Published by Ginn & Co., New York, 1910; 133 pages, 6x9 inches; 64 illustrations. Price, cloth $2.

A purely theoretical treatise adapted especially to the needs of the class room. The text presupposes a knowledge of calculus and is intended to follow a college course in general physics, although a brief résumé is given of such portions of this subject as are essential as a basis upon which to develop the sub-

ject of thermodynamics. It is felt that many of the definitions of the fundamental terms could have been expressed less vaguely, and the addition of more tables would have added greatly to the usefulness of the book.

MECHANICAL ENGINEERING. By Charles M. Sames. Published by the author, at Jersey City, N. J. Flexible leather; 218 pages, 4x6½ inches; illustrated. Price, $2.

This is the fourth annual edition of Mr. Sames' handy little pocketbook and, although its thickness does not appear to have been increased appreciably, it contains no small quantity of new material. This achievement, however, has its drawbacks. The contents are so condensed that it is not always easy to grasp the sense of a statement and the typographcial congestion is confusing to the eye.

The reviewer has not looked for errors, but noticed accidentally an incorrect statement at the bottom of page 59 and several at the top of page 61.

SOCIETY NOTES

A meeting of the Boston section of the American Institute of Electrical Engineers, with the coöperation of the American Society of Mechanical Engineers and the Boston Society of Civil Engineers, will be held on Friday evening, February 17, in that city. R. A. Philip, of the Stone & Webster Engineering Corporation, an associate member of the American Institute of Electrical Engineers, will present a paper on certain phases of the general subject of economic limitations to aggregation of power systems.

The Mississippi Electric Association, which represents the central-station industry of the State, had a meeting at Meridian, Miss., on January 19, when, after thoroughly canvassing the wishes of the members and receiving a unanimous indorsement, it was voted to affiliate with the National Electric Light Association. The president, A. B. Patterson, and A. H. Jones, secretary and treasurer, were instructed to make the necessary arrangements with the national body for putting this affiliation into effect. The national society has already a number of members in the State and this new union will be particularly beneficial to the smaller companies that hitherto have belonged to the local organization only.

On Saturday evening, January 28, 1911, Colonel Goethals Branch No. 1 of District 9 of the Institute of Operating Engineers was formed at Yazoo City, Miss., with a charter membership of 13. The election results are as follows: F. C. Holly, branch chairman and representative to district council; L. B. Smith, secretary and treasurer; F. C. Holly, W. W. Brannon, W. G. Richardson, councilmen for three years; Davis Chisholm, W. R. Vernon, Albert Walker, councilmen for two years; Ray Madden, Parks and Wince Hoover, councilmen for one year. W. G. Richardson, lecturer on apprenticeship training and plant operation and chairman of committee on apprenticeship training; W. W. Brannon, lecturer on educational subjects and chairman of committee on educational subjects. The chairman appointed Messrs. Vernon and Walker as assistant lecturers on apprenticeship training and plant operation, and Walker and Chisholm were appointed as assistant lecturers on educational subjects. The meetings of this branch are to be held the second and fourth Saturday nights of each month. The address of the secretary and treasurer is, P. O. Box 297, Yazoo City, Miss.

The annual banquet of the Atlantic City Council of the American Order of Steam Engineers has for some time assumed a more than local color. The fourteenth banquet, held on February 4 at the Hotel Windsor, drew a number of visitors from New York, New Jersey and Pennsylvania, including representatives of the State legislatures of New Jersey and Pennsylvania.

The large banquet hall of the hotel was filled with the members and their guests. After the inner man had been satisfied, an address of welcome was made by John Best, who also introduced the toastmaster, Mayor Franklin P. Stoy, of Atlantic City. The speakers included Senator Walter E. Edge, Postmaster Harry Bacharach, and Assemblyman Isaac Bacharach, who was responsible for Atlantic City getting the State legislature to grant it permission to pass the engineers' license law. Mr. Bacharach spoke of the great advantage to the city of having licensed men in charge of the power plants of the hotels, thus insuring to their guests that the boilers, etc., were in competent hands.

Over two hundred licenses have so far been granted.

Boiler Tube Bursts

It is reported in the daily press that on January 26 two firemen were seriously burned by the bursting of a boiler tube in the plant of the Alkali Rubber Company, Akron, O.

Boiler Explosion in Kentucky

On February 2, a boiler in a grist mill at Bruin, Elliott county, exploded, killing two men and injuring others. At the present writing further particulars are not available.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 3.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Commander U. T. Holmes, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., O. P. Chamberlain; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Pres., R. P. Bolton; sec., W. W. Macon, 29 West Thirty-ninth street, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe. Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

BUSINESS ITEMS

William D. Purcell has been appointed manager of the New York office of the Home Rubber Company, 80 Reade street.

The Reliance Gage Column Company, Cleveland, Ohio, reports that its January business for this year is very much in excess of that of the same month a year ago.

E. W. Puckett, for ten years president and manager of the Fort Wayne Oil and Supply Company, has accepted the position of vice-president and sales manager of the Republic Belting Company, of Cleveland.

The Westinghouse Electric and Manufacturing Company has recently closed a contract with the Universal Portland Cement Company, for motors to operate its No. 6 plant, at Buffington, Ind. The motors will be of the "MS" mill type, having characteristics specially suitable for cement mill work, and they will operate from five to 200 horsepower and the aggregate capacity is 11,500 horsepower. This plant will be the largest in the United States, having a daily capacity of approximately 12,000 barrels, and will be electrically operated throughout, the various drives being of the latest development for cement-mill work.

A change in management has taken place at the Howard Iron Works, Buffalo, N. Y. The following officers and directors were elected on January 24: President, Alvan H. Alberger; vice-president, Edward B. Holmes; secretary and treasurer, George H. Gardner; J. H. McNulty and Harvey L. Brown. The new management intends to continue the business as founders and machinists, manufacturers of transmission machinery, Burdict nut and bolt machines and general machinery repairs, as heretofore. The Alberger Gas Engine Company, recently incorporated with a capital stock of $221,000, has acquired substantially all the capital stock of the Howard Iron Works and has also acquired the gas-engine business which has been conducted by the A. H. Alberger Company. The Alberger gas engine will also be built at the Howard Iron Works.

The Busch-Sulzer Brothers Diesel Engine Company was incorporated at St. Louis, Mo., January 26, 1911, with a capital stock of $2,100,000. The officers and directors are: Adolphus Busch, president; August A. Busch, first vice-president; James R. Harris, second vice-president; and general manager. Edward A. Faust; E. D. Meier, president American Society of Mechanical Engineers, New York; Robert Sulzer, of Gebrüder Sulzer, Winterthur, Switzerland; Eugene Angert, attorney, St. Louis; Rudolph Diesel, engineer, Munich, Germany; Daniel N. Kirby, Nagel & Kirby, attorneys, St. Louis. The board of directors will consist of 11 members, two of whom, as well as the secretary and treasurer of the new company, remain to be selected. The main business of the new corporation will be the building and selling of the Diesel oil engine, and in the very near future it will erect a modern and complete plant.

NEW EQUIPMENT

The city of Lott, Tex., will construct waterworks.

Dodge City, Iowa, will install a municipal lighting plant.

A. B. Lorino, Matagorda, Tex., will establish an ice plant.

Bowmanville, Ont., will install a new waterworks system.

Adair, Iowa, will build a municipal power and pumping plant.

Camrose, Alberta, will spend $100,000 on a new waterworks system.

Santa Barbara, Cal., will make improvements in its water system.

Arlington, Ore., contemplates the installation of an electric-light plant.

Webster City, Iowa, has procured site for a new power and light plant.

Two new electric pumps will be installed at the waterworks, Bedford, Ind.

The Martinsburg (W. Va.) Power Company will install a turbo-generator.

The town of Arnprior, Ont., will install a plant for pumping by electricity.

The Bourne Mills, Fall River, Mass., are in the market for a steam boiler.

The Clinton (N. Y.) Knitting Company is to install a 50-horsepower engine.

Fire destroyed the pumping station of the Soo railway, at Abbottsford, Wis.

McMinnville, Ore., will spend $30,000 on improvements in its water system.

The Henry (S. D.) Light and Power Company has been granted a franchise.

The Eastern Michigan Edison Company will erect a power plant at Amy, Mich.

Kingsport, Tenn., is having plans prepared for the construction of waterworks.

Haskell, Okla., has voted $25,000 bonds for the construction of waterworks.

The Gardner Governor Company, Quincy, Ill., will install a new power plant.

The Northwestern Railroad will install an electric-light plant at Baraboo, Wis.

The Staunton (Va.) Lighting Company will instal a 500-kilowatt turbo-generator.

Auburn, Iowa, has plans for the construction of a $10,000 waterworks system.

C. C. Murray & Sons, Madisonville, Tex., contemplate establishing an ice plant.

The Winnipeg (Man.) Electric Company is erecting a large turbine power house.

The Fremont (Neb.) Gas and Electric Company will enlarge and improve its plant.

The Lonsdale Company, Cumberland, R. I., will install new power-house equipment.

The citizens of Deming, N. M., voted to issue $35,000 bonds for a sewer system.

Maryville, Tenn., contemplates the construction of waterworks and sewer system.

The Kibbe Brothers Company, Springfield, Mass., will install a 150-horsepower engine.

The Olympia (Wash.) Power Company is building a power plant on the Elcoha river.

The Jones-Macintyre Candy Company, Tacoma, Wash., will erect a new boiler house.

The Middleboro (Mass.) Gas Company contemplates the erection of a new gas plant.

The city of Yacolt, Wash., will make extensive improvements in its water system.

A. O. Rothenburg, 42 Court street, Boston, Mass., is in the market for a steam boiler.

The Glendora (Cal.) Mutual Water Company will install new pumping equipment.

The city of El Centro, Cal., is planning improvements in its sewer and water systems.

Snyder, Okla., has voted on issuance of $15,000 bonds for extending its waterworks.

The Whaling City Mills, New Bedford, Mass., will install boilers, engines and pumps.

Many, La., plans the construction of an electric-light plant, waterworks and ice plant.

The International Rubber Company, Barrington, R. I., will build a new boiler house.

The Cleveland (Ohio) Electric Illuminating Company is erecting a new power house.

The city of Eugene, Ore., is contemplating the installation of a municipal lighting plant.

The Torreon (Mex.) Mercantile Company will install an ice plant at Velardena, Mex.

The boiler house at the city light plant, at Hibbing, Minn., was burned. Will be rebuilt.

W. D. Quimby & Co., Boston, Mass., are in the market for a 15-ton refrigerating machine.

The Woodside Woolen Company, Northboro, Mass., will require new power-plant equipment.

The Missisquoi Lumber Company, Rockford, Vt., is making additions to its power plant.

The Boston (Mass.) Cold Storage and Terminal Company is to erect a seven-story addition.

The Wakefield (R. I.) Water Company will install a pump of 4,000,000 gallons daily capacity.

The Federal Motor Truck Company, Detroit, Mich., is in the market for an air compressor.

The Springfield (Mass.) Gaslight Company is to install new equipment at a cost of $250,000.

The Hemet (Cal.) Ice Company will double the capacity of its plant. W. E. Kimball, manager.

Ham & Watson, Spokane, Wash., will make extensive alterations in their boiler room and equipment.

The Sacramento Valley Power Company, San Francisco, Cal., will make extensive improvements.

J. E. Englehorn, Kooskia, Idaho, has been granted a franchise for an electric-light and power plant.

Franchise has been granted to Peter A. Orth at Menno, S. D., to install an electric-light system.

The Lynnhaven hotel, Norfolk, Va., will install a new ice plant in connection with its power plant.

The Nagle Packing Company, Jersey City, N. J., will enlarge its plant and erect a new power house.

C. E. Newton & Brother, Macon, Ga., contemplates the erection of an ice and cold-storage plant.

The Lorraine Manufacturing Company, Pawtucket, R. I., will install two 250-horsepower boilers.

The town of Old Saybrook, Conn., is in the market for electrical equipment. Address Wm. H. Smith.

The city of Tacoma, Wash., will expend $1,500,000 on proposed gravity water system on Green river.

The Hoosac Cotton Mills, North Adams, Mass., is contemplating changes in power-house equipment.

The Crystal Ice Company, Logan, Ohio, will erect a new plant, having outgrown present capacity.

Wm. P. Powel, 100 Austin street, Cambridge, Mass., is in the market for an air compressor and storage tank.

The city of Dothan, Ala., will construct electric-light plant and waterworks. R. W. Lisenby, city clerk.

The Telluride Power Company, Ely, Nev., contemplates the erection of a power plant on Cleveland creek.

The city of Worcester, Mass., contemplates installing an electric-light plant at the Worcester county jail.

The Northern Ohio Traction Company, Canton, Ohio, will erect a $1,250,000 power plant at Cuyahoga falls.

The Pike County Water Company, Murfreesboro, Ark., is having plans prepared for hydroelectric plant.

The substation of the Fort Dodge, Des Moines & Southern Railroad, at Boone, Iowa, was destroyed by fire.

The Ingling-Martin Brick Company, Johnsonburg, Penn., contemplates the installation of an electric generator.

W. T. & O. W. Killam have applied to the city council, Grove, Okla., for a franchise for an electric-light system.

The city of Richmond, Va., is planning the installation of a cold-storage plant in Second Market to cost $70,000.

The Lynchburg (Va.) Traction and Light Company will install a 1500-kilowatt steam turbine generating unit.

C. R. Thompson, of Richland Centre, Wis., is preparing plans for a municipal electric-light plant at Viola, Wis.

The engine room at the river works of the General Electric Company, Lynn, Mass., was wrecked by an explosion.

The Olympia Power Company, Port Townsend, Wash., will make improvements and extensions in its system.

The National Cold Storage and Ice Company, Portland, Ore., will erect a two-story addition for its ice plant.

The commissioners, Emporia, Kan., are said to be contemplating the purchase of a new 3,000,000-gallon pump.

The Columbia Electric Light and Power Company, of Pardeeville, Wis., will build a lighting plant at Rio, Wis.

J. E. Baker, Killeen, Tex., has purchased an electric-light plant, at Lometa, Tex. Will enlarge and improve same.

The Jacksonville (Fla.) Electric Company is planning the construction of a power plant to cost over $400,000.

R. G. Arthur, Bisbee, Ariz., has been granted franchise for an electric-light and power plant, at Benson, Ariz.

The Calzona Land Company, Los Angeles, Cal., is having plans prepared for a waterworks plant and power station.

The Yuma (Ariz.) Ice and Cold Storage Company has let contract for the construction of a new cold-storage building.

The Celina (Tex.) Electric Light and Power Company has been granted a franchise to construct an electric-light plant.

Bids will be received at Huron, S. D., sometime in February, on a pumping plant of 2,000,000 gallons daily capacity.

The Hamm Brewing Company, St. Paul, Minn., will erect a refrigerating and cold-storage plant at Mobridge, S. D.

The Tyler & Simpson Wholesale Grocery Company, Ardmore, Okla., is having plans prepared for a cold-storage plant.

The Bergner & Engle Brewing Company, Philadelphia, Penn., will build a new boiler and engine house to cost $27,000.

Bevin Brothers Manfacturing Company, East Hampton, Conn., will install a hydroelectric plant at Skinnerville, Conn.

The Rogue River Electric Company, Medford, Ore., is planning for the erection of a 75,000-horsepower plant at Prospect.

The Fourteenth Street Store, Sixth avenue and Fourteenth street, New York, will install a complete electrical-generating plant.

The Peter S. Van Kirk Company, Lakeview, N. J., will install two new boilers and make other improvements in its power house.

The Hampden Machine Screw Company, Springfield, Mass., will install a 125-horsepower gas-producer plant in the near future.

City of Lubbock, Tex., will construct waterworks and sewer system to cost about $85,000. E. L. Dalton, Dallas, Tex., engineer.

R. E. Porterfield, Libby, Mont., has been granted franchise to erect a waterworks system and electric-lighting plant at Troy, Mont.

The New York & Ontario Power Company has let contract for the construction of a 15,000-horsepower plant at Waddington, N. Y.

The Philadelphia Suburban Gas and Electric Company will build a new power house at Pottstown, also a substation at Sanatoga.

The Board of Public Works, Escanaba, Mich., has been authorized by the city council to have plans prepared for a municipal gas plant.

The city of Tupelo, Miss., contemplates voting on issuance of $15,000 bonds for improving its electric-light plant. D. W. Robins, mayor.

The city of Snohomish, Wash., is making preparations for extending and improving its water system. Bonds for $110,000 will be voted.

A refrigerating plant will be installed in the new Casino building to be erected by the Anheuser-Busch Brewing Company, at Santa Monica, Cal.

The Northwestern Electric Company, Tacoma, Wash., has acquired power site and is said to be contemplating the erection of a power plant.

The Thousand Springs Power Company, Mountainhome, Idaho, will build a power plant on Snake river, and a pumping plant near Brown's flats.

The city clerk, Colton, Cal., has been authorized to advertise for bids for one 600 cubic foot air compressor ,two electric motors, two transformers.

The Los Angeles (Cal.) Gas and Electric Company is planning for extensions and improvements, which will involve an expenditure of $1,000,000.

The Highland Paper Company, Johnsonburg, Penn., is erecting a new boiler house. Will install four new boilers to replace the twelve now in use.

The Fulton (N. Y.) Light, Heat and Power Company has let contract for the erection o a new steam power plant at East First and Van Buren streets.

A power plant will be installed in the Polytechnic High School to be erected at San Francisco, Cal., for which city architect A. I. Coffey is preparing plans.

The Rogue River Valley Gas Company, of Los Angeles, Cal., operating at Grant's Pass, Ore., is contemplating the erection of a gas plant to cost about $100,000.

Power-plant and refrigerating machinery will be installed in the apartment hotel to be built by the South Main Street Improvement Company, Los Angeles, Cal.

The Vincennes (Ind.) Electric Company has been incorporated by W. T. Barnes, A. J. Heitz and C. W. Sherman to generate electricity for heating, lighting and power.

The city of Nicholasville, Ky., is considering the installation of a 150-horsepower boiler and 75-horsepower steam engine in its electric-light plant. E. J. Glass, manager.

The Longacre Electric Light and Power Company, of which Ex-Senator Jas. F. Shaw, of Boston, is president, contemplates the expenditure of $10,000,000 in the initial plant.

The Wayne Cold Storage Company, East Williamson, N. Y., has been incorporated with $50,000 capital to do a general cold-storage business, by Jos. J. Gates, R. C. Wilson, D. Wagemaker.

E. H. Rose, of Los Angeles, Cal., has purchased the property of the Needles (Cal.) Light and Power Company and will make extensive improvements. A new power plant will be built.

The Winnemueca (Nev.) Water and Light Company is contemplating the installation of a 500-kilowatt direct connected steam turbine driven unit; also water-tube boilers fitted for burning oil.

The Cascade Light and Power Company, Vancouver, Wash., has been incorporated with $2,000,000 capital and will erect a power plant on the Lewis river. H. W. Arnold is at the head of the company.

The Pennsylvania Railroad Company will make considerable improvements at the Euclid avenue station, Cleveland, Ohio, and it is said will require power plant for operation of elevators, switches and signals.

The city of Dalton, Ga., will receive bids up to February 24, for furnishing materials and making extension to its electric-light plant and waterworks. H. S. Jaudis Engineering Company, Savannah, engineers.

Proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 a.m., February 11, for six oil tanks with pumps, meters, gages, piping, etc., for the navy yard, Portsmouth, N. H.

Proposals will be received until 10 a.m., February 14, by the Department of Justice, Superintendent of Prisons, Washington, D. C., for electric-light and power equipment at the United States penitentiary, Atlanta, Ga. Specifications can be had of R. V. Ladow, superintendent of prisons.

Proposals will be received until 10 a.m., February 16, by the Department of Justice, Superintendent of Prisons, Washington, D. C., for installing electric-light and power equipment at the United States penitentiary, Leavenworth, Kan. Specifications can be had of R. V. Ladow, superintendent of prisons.

NEW CATALOGS

O. D. Havard Company, Scranton, Penn. Circular. Havard coal meter. Illustrated.

Kerr Turbine Company, Wellsville, N. Y. Bulletin No. 12. Kerr exhaust steam turbine. Illustrated, 24 pages, 6x9 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 153. Patent steel-belt lacing. Illustrated, 12 pages, 8x10½ inches.

Wm. B. Scaife & Sons Company, Pittsburg, Penn. Catalog. Range boilers and high-pressure tanks. Illustrated, 30 pages, 6x9 inches.

Lagonda Manufacturing Company, Springfield, Ohio. Catalog L. Weinland turbine boiler-tube cleaners. Illustrated, 48 pages, 5x7 inches.

Positive Differential System Company, Vanderbilt building, 132 Nassau street, New York. Catalog. Gravity-return line systems. Illustrated, 8 pages, 6x9 inches.

The Hamler-Eddy Smoke Recorder Company, 3906 South Halsted street, Chicago, Ill. Catalog. Eddy smoke recorder. Illustrated, 16 pages, 4½x6½ inches.

Alberger Condenser Company, 140 Cedar street, New York. Catalog No. 14. Wainwright water heaters and expansion joints. Illustrated, 44 pages, 6x9 inches.

Schutte & Koerting Company, Philadelphia, Penn. Catalog 6, Section A. Centrifugal spray nozzles. Illustrated, 12 pages, 8x11 inches. Catalog 6, Section B. Koerting spray cooling. Illustrated, 4 pages, 8x11 inches.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

NOT long ago the Federation of Trade Press Associations and the American Trade Press Association held a joint banquet in New York.

The members of these associations are publishers of trade and technical papers.

Let us say right here that there is a general misunderstanding of the meaning of "trade" and "technical" as applied to papers. The word "trade" is a general term wrongly used to cover every kind of a periodical outside of general and religious magazines. As a matter of fact a trade paper is one which appeals to *dealers* in different industries who buy goods to sell at retail. The technical paper—of which POWER is an example in the engineering class—appeals directly to users and buyers of goods.

At this banquet one of the interesting and instructive speeches was delivered by Wm. H. Ingersoll, advertising manager of R. H. Ingersoll & Bro., makers of the famous Ingersoll watch.

Probably every man in the country has heard of Ingersoll watches and millions carry them. Fourteen thousand are made and sold every day.

"The world lives on two things," said Mr. Ingersoll, "the production of goods and the distribution of them."

Distribution of goods means the selling of them. Mr. Ingersoll pointed out very clearly that any method of distributing goods costs real money, and that the most economical method was advertising. Hence, advertising, instead of adding to the cost of goods, actually reduced the cost by using the most economical method of selling that is known.

When a concern succeeds, as Mr. Ingersoll's concern has succeeded, in making and marketing an accurate time-keeper at $1.00 retail, it proves the point.

At a general meeting of salesmen of the Ingersoll Company, it was shown that every time a seven-jewel, or better, grade of watch is sold, a workman is given and paid for a day's work. These are watches retailing for more than $100. And these salesmen went out with that thought in their minds and the advertising is being done with that thought behind it, with the result that both salesmen and advertising are booming the business.

Many POWER readers may wonder why we talk advertising so much. One reason is the purely business one that we want to advertise our own advertising. The other is that "for every watch *sold* a man is employed and paid for a day's work."

Advertising is the greatest factor in distribution and upon distribution depends the salaries of all of POWER's readers, and our own modest stipend. Why, then, should not the subject of advertising be of interest to every man old enough to know what it means?

Advertising can be a tremendous power for good or evil, depending wholly upon how it is conducted.

This power touches intimately the life of every man and woman.

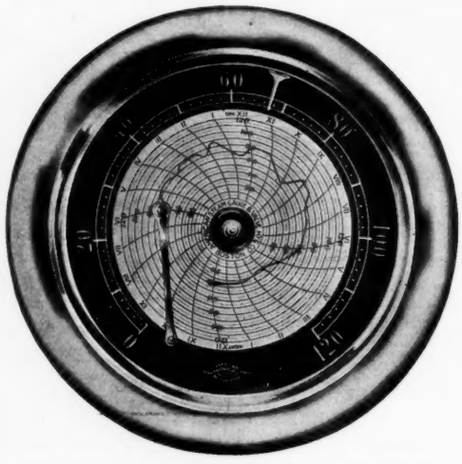
Civilization comes about through the distribution of commodities, and the latter comes about through the transportation facilities of the country and the information of how, where and when to get what we want or what will be good for us—in other words, plain advertising.

If it were not for this distribution, you know as well as we that each community would be a world unto itself, and each would be living in a sort of "darkest Africa" condition.

Now, if this be true, and if advertising in some of its multiple forms is playing its big part in the good work, isn't it worth while to tell all we can about it to those of our readers who, now or sometime, must buy things for use in their work?

Yea, verily!

You Can Stay Away From The Plant As Long As You Like



The American Pressure and Recording Gauge.

Without fear that the work in the boiler room will be neglected.

You can *know* without a question of doubt exactly what pressure has been carried on the boiler at any time.

You can tell whether the fireman has been sleeping on his job or not—

Just by a glance at

The American Pressure And Recording Gauge

This instrument keeps accurate tabs on "Boiler doings" at all times—

It records the pressure carried on the boiler every hour of the day and every hour of the night.

It supplies indisputable proof of incompetent firing and likewise of firing well done.

It can be placed in the engine room or in the managers office.

And the daily records can be kept on file so that they form a constant and reliable guide to the man-at-the-head as to whether the men in the power plant are watching things.

So that if you be fireman or engineer you want this device in your plant to prove that your work is being done properly.

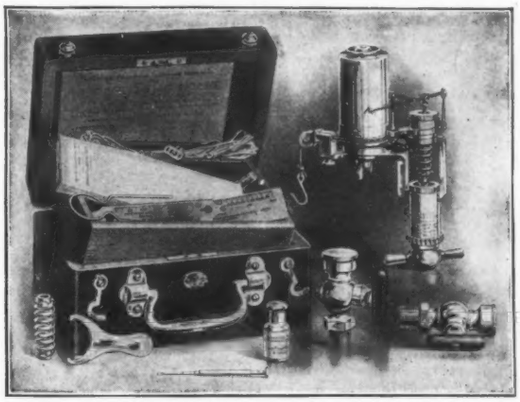
If you be manager you want it to keep yourself informed as to the *exact* conditions in the boiler room.

A request brings complete details of this as well as our other steam specialties.

American Steam Gauge & Valve Mfg. Company

Boston, - - - - Mass.

New York, 26 Cortlandt St. Atlanta, 525 Candler Bldg. Chicago, 130-132 Jefferson St. Pittsburg, Columbia Bank Bldg. San Francisco, Monadnock Bldg. Montreal, 444 St. James St. Los Angeles, 213 So. Los Angeles St.



$5.00 Brings The American-Thompson $5.00 Per Month Pays For The Balance

And the minute you take your American-Thompson out of its mahogany box it will help you save money, time and power.

It's the one QUALITY indicator—accurate today, tomorrow, *always*.

With it you'll always have the proof needed to convince the boss that he is securing power for the least possible cost.

You'll always be able to show that there are no leaks inside the cylinder, no improperly adjusted valves—

An engineer without an indicator can't do these things.

In other words, the American-Thompson will give you confidence in yourself; will help you make yourself a better engineer; will make you eligible for the better paying position. It will also give you the best help you can have if you ever apply for another job. Because this quality indicator is the mark of a quality engineer.

And $5.00 brings it to you, $5.00 monthly pays the balance—terms that are easily within your means.

Besides that, you have the privilege of examining the outfit for a period of five days.

If you're not completely satisfied with your purchase your money will be refunded without question.

Take advantage of this offer *now*—you'll be the gainer.

Send the first payment today and we'll start your American-Thompson on its way to you at once.

Kindly mention Proposition No. 97 when writing.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

If You Want Further Details Sign, Tear Out And Mail The Arrow Point Today

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

Send me full details of your Indicator Offer No. 97.

Name . . . . . .

Address . . . . . .

City and State . . . . . .

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PRODUCER erecting engineer wanted. Box 377, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

WANTED—Experienced salesman to sell the Rolin patent adjustable grate bar; exclusive territory and liberal commission. Write Standard Grate Company, Heed building, Philadelphia.

DRAFTSMAN WANTED—An experienced mechanical draftsman, preferably with a technical education, or a number of years' practical shop experience, by a large manufacturing concern in Massachusetts; state age, experience and salary expected by addressing Box 367, POWER.

SUBSTANTIAL mining company in Mexico require the services of an A-1 experienced master mechanic, thoroughly up in electrical and mechanical engineering, and mining and milling machinery in general; give full particulars and references; salary $200. Address "L. T. C.," Box 374, POWER.

A YOUNG MAN to take charge of boiler houses of a large steel plant in the Chicago district; must have previous experience and good record in a similar position and must have thorough knowledge of economical production of steam; replies should state experience, references and salary expected. Address "P. L. V.," 1300 Trude Bldg., Chicago.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

MECHANICAL ENGINEER, with several years' experience as superintendent of shops and in charge of erecting force building and installing steam engines, at present employed, is desirous of making a change. Box 375, POWER.

SPLENDID OPPORTUNITY for salesmen familiar with boilers and boiler room practices, selling devices of approved merit on commission; state age, experience and reference. Address "Liberal Commissions," Box 379, POWER.

POSITION WANTED by a married man, 28 years old, as electrician and engineer; familiar with power house equipment, wind and repair alternating and direct current motors and generators; references from all past employers. Box 378, POWER.

WANTED—Position as chief in any kind of steam plant up to 1500 horsepower, or assistant engineer in any size plant; am sober, steady and married; first class Ohio license; go any where; first class pump man; some refrigerating experience; good references; open March 1, sooner if necessary; no night work; nothing under $75 per month considered. Address Box 376, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

ELECTRICAL ENGINEERING—An opportunity to learn above trade at specially low rates; by entirely new methods we have prepared a course of instruction for $10 only, easy payments; at any rate, see what we have to say before paying more. P. O. Box 811, Cincinnati, Ohio.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—125 h.p. Westinghouse gas engine, complete with ignition set, first class condition. Address Box 373, POWER.

FOR SALE—A $130 scholarship with International Correspondence Schools; will sacrifice for cash. E. F. Banette, St. Albans, Vt.

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., 424 Madison St., South Bend, Ind.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ALPHABETICAL INDEX TO ADVERTISERS

PAGE

Acheson Graphite Co., International 82
Ajax Iron Works..... 112
Akron Metallic Gasket Co.... 78
Albany Lubricating Co..... 81
Alberger Condenser Co..... 104
Allis-Chalmers Co..... 116
Alton, Laine & Co..... 89
American District Steam Co.. 111
American Eng. Co..... 115
American Goetze-Gasket and Packing Co.....1st cover
American Mfg. Co..... 100
American Metal Hose Co..... 106
American Radiator Co..... 92
American Ship Windlass Co.. 95
American Steam Gauge and Valve Mfg. Co.....64 and 65
Ames Iron Works..... 116
Anderson Co., V. D..... 93
Armstrong Mfg. Co..... 89
Ashcroft Mfg. Co..... 83
Ashton Valve Co..... 89
Austin Separator Co..... 92

Babcock & Wilcox Co..... 107
Baker Valve Co..... 110
Ball & Wood Co..... 115
Ball Engine Co..... 115
Baragwanath & Son, Wm.... 102
Barnes Co., W. F. & John.... 107
Beggs & Co., Jas..... 105
Bignall & Keeler Mfg. Co.... 89
Blake & Knowles Steam Pump Works 102
Bogart Gas Power Engineering Co..... 113
Bowers Rubber Works..... 98
Bristol Co.....4th cover
Brownell Co..... 108
Bruce-Macbeth Engine Co.... 112
Buckeye Engine Co..... 117
Builders Iron Foundry..... 111
Burt Mfg. Co..... 18

Cameron Steam Pump Works, A. S..... 104
Cancos Mfg. Co..... 97
Casey-Hedges Co..... 107
Cataract Refining & Mfg. Co.. 81
Chapman Valv Mfg. Co..... 88
Chesterton Co., A. W..... 86
Cling-Surface Co..... 101
Columbian Rope Co..... 100
Consolidated Safety Valve Co. 83
Cooper Co., C. & G..... 115
Crosby Steam Gage & Valve Co. 87
Curtis & Curtis Co..... 89

Dart Mfg. Co., E. M..... 86
Dearborn Drug & Chemical Works 5
Deming Co..... 104
Detroit Lubricator Co..... 80

PAGE

Diamond Rubber Co..... 98
Dixon Crucible Co., Jos..... 80
Du Bois Iron Works..... 113

Elliott Co..... 7
Elyria Gas Power Co..... 113
Epping-Carpenter Co..... 104
Erie Mfg. & Supply Co..... 102
Eureka Packing Co..... 71

Fitchburg Steam Engine Co.. 115
Foos Gas Engine Co..... 110
Fort Wayne Electric Wks.... 112
Foster Engineering Co..... 88

Garlock Packing Co..... 9
General Electric Co..... 76
Goulds Mfg. Co..... 104
Greene, Tweed & Co., 82 and 4th cover
Grinith & Wedge Co..... 117
Griscom-Spencer Co..... 103

Hammel Oil Burner Co..... 78
Hancock Inspirator Co..... 83
Harbison-Walker Refractories Co. 109
Harris Steam Engine Co., W. A..... 116
Harrisburg Fdry. and Mach. Works 114
Harrison Safety Boiler Wks.. 67
Hawkes Boiler Co..... 108
Hayden & Derby Mfg. Co..... 83
Heine Safety Boiler Co..... 108
Hewes & Phillips Iron Wks... 116
Hoffman, Geo. W..... 104
Homestead Valve Mfg. Co.... 88
Hooven, Owens, Rentschler Co. 117
Hoppes Mfg. Co..... 103
Houston, Stanwood & Gamble. 110
Hughson Steam Specialty Co. 88
Huyette Co., Inc., Paul B.... 89

Ingersoll-Rand Co..... 114
International Textbook Co.... 73

Jamieson & Co., M. W..... 104
Jefferson Union Co..... 14
Jeffrey Mfg. Co..... 97
Jenkins Bros..... 69
Johns-Manville Co., H. W.... 79

Keeler Co., E..... 108
Kellogg & Co., E. H..... 80
Kellogg, M. W..... 90
Kennicott Co..... 107
Kerr Turbine Co..... 114
Keystone Lubricating Co..... 3
Kingsford Fdry. & Mach. Wks. 108

Lagonda Mfg. Co.....3d cover
Laidlaw-Dunn-Gordon Co..... 114
Leddell-Bigelow Co..... 111
Liberty Mfg. Co..... 7

PAGE

Long Grate Bar Co..... 84
Lunkenheimer Co..... 4

McClave-Brooks Co..... 12
McCord Mfg. Co..... 99
McGraw-Hill Book Co..... 74
McIntosh, Seymour & Co..... 115
McLeod & Henry Co..... 108
Magnolia Metal Co..... 110
Manning, Maxwell & Moore... 83
Manzel Bros. Co..... 81
Mason Regulator Co..... 86
Mietz Iron Fdry. & Machine Works, August..... 84
Minneapolis Steel & Mach. Co. 113
Monarch Valve & Mfg. Co.... 88
Morehead Mfg. Co..... 93
Morrin Climax Boiler Co..... 107
Murphy Iron Works..... 97

Nagle Corliss Engine Wks.... 115
National India Rubber Co.... 98
National Pipe Bending Co.... 102
National Tube Co..... 86
Neemes Bros..... 97
Nelson Valve Co..... 85
New Bedford Valve Mfg. Co.. 86
New Process Raw Hide Co... 100
New York & New Jersey Lubricant Co..... 80
New York Belting & Packing Co., Ltd..... 10
New York Edison Co.....106
Newhall Engr. Co., Geo. M.... 77
Northern Equipment Co..... 106
Nugget Packing Co..... 97

Ohio Blower Co..... 91
Ohio Brass Co..... 87
Oil City Boiler Works..... 84
Open Coil Heater & Purifier Co. 93

Parson Mfg. Co..... 94
Patterson & Co., Frank L.... 102
Peerless Rubber Mfg. Co..... 8
Penberthy Injector Co..... 13
Pennsylvania Flexible Metallic Tubing Co..... 86
Perfection Grate Co..... 97
Philadelphia Grease Mfg. Co. 82
Pierce Co., Wm. B.....2d cover
Pittsburgh Valve, Fdry. and Construction Co. 88
Powell Co., Wm..... 88
Power Specialty Co..... 98
Precision Instrument Co.....106
Providence Engineering Wks.. 117

Reliance Gauge Column Co...106
Richardson-Phenix Co..... 78
Ridgway Dynamo and Engine Co. 115
Robb Engineering Co., Ltd...107
Robertson & Sons, Jas. L.... 75
Rollins Engine Co.....114

PAGE

Ruggles Co., Walter G..... 86

St. John, G. C.....110
Salamander Grate Bar Co.... 97
Scaife & Sons Co., Wm. B....107
Schaeffer & Budenberg Mfg. Co. .....4th cover
Schieren Co., Chas. A.....100
Schuchardt & Schutte.....103
Schutte & Koerting Co..... 96
Simmons Co., John..... 95
Simplex Engineering Co..... 90
Skinner Engine Co.....117
Smooth-On Mfg. Co..... 6
Squires Co., C. E..... 90
Standard Grate Co..... 97
Standard Oil Co..... 80
Starrett Co., L. S.....102
Steam Appliance Co., The... 93
Steel Mill Packing Co..... 98
Stone Co., J. B.....100
Struthers-Wells Co.....113
Sturtevant Co., B. F.....110

Thermoid Rubber Co..... 11
Toledo Pipe Threading Machine Co..... 88
Treadwell Co., M. H..... 97
Trill Indicator Co..... 78
Trimont Mfg. Co..... 94
Tripp Metallic Packing Co... 98
Turbo-Blower Co..... 80
Turner-Fricke Mfg. Co..... 112

Uehling Instrument Co.....107
Under-Feed Stoker Company of America 96
Underwood & Co., H. B..... 110
Union Steam Pump Co..... 104
Universal Lubricator Co..... 15

Vilter Mfg. Co., The.....116
Vogt Machine Co., Henry....107

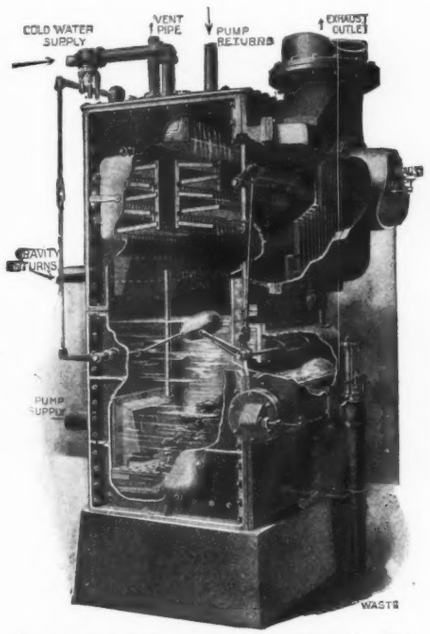
Walton Co., F. S.....16 and 17
Washburn & Granger..... 97
Watson & McDaniel Co..... 103
Watts-Campbell Co.....116
Westinghouse Elec. & Mfg. Co. 118
Wheeler Mfg. Co., C. H..... 104
Whitlock Coil Pipe Co..... 88
Wickes Boiler Co.....108
Wilkinson Fdry. & Mfg. Co., The 94
Willcox Engineering Co..... 79
Williams & Co., J. H..... 94
Williams Fdry. & Mach. Co.. 98
Williams Tool Co.....102
Wing Mfg. Co., L. J..... 94
Worthington, Henry R.....104
Wright Mfg. Co..... 92

Yale & Towne Mfg. Co..... 78
York Mfg. Co.....110

Ziermore Regulator Co..... 79

Steam Costs From 12 to 50 cts. per 1000 lbs. Don't Waste It

Figures relating to an electric power station of 6000 Kw. capacity recently prepared showed that steam delivered to the engine cost 12.9 cents per 1000 lbs., when using coal costing $1.26 per ton. An analysis of other figures shows that in a boiler plant running 24 hours per day, 310 days per year, the cost of steam. with coal at $3 per ton and including all other charges, is 19 cents per 1000 lbs., while in a plant of the same character, using coal at the same price, but running only 10 hours per day, 310 days per year, the cost for steam becomes slightly more than 21 cts. per 1000 lbs. In smaller plants, especially those using hard coal, the cost may be considerably higher, perhaps as much as 50 cts. per 1000 lbs.



Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver

Now, an automatic engine of moderate size, such as is usually installed for lighting and power in hotels, office buildings, factories, etc., will use from 30 to 35 lbs. of steam per H.P. hour. Taking the lower figure, a 100 H.P. engine will, in a day of ten hours, exhaust 30,000 lbs. of steam.

Now, for heating or drying purposes, this exhaust steam is just as valuable as live steam, provided it is purified of oil by passing through a **COCHRANE OIL SEPARATOR.** A 100 H.P. engine will then exhaust each day about $5 worth of steam, which if there are 200 days in a heating season, would amount to $1000, which is a good many times more than a Cochrane Combined Heater and Separator would cost.

The unique superiority of the **COCHRANE-STEAM-STACK** and **CUT-OUT VALVE HEATER** and **RECEIVER** in connection with exhaust steam heating systems lies in the fact that it combines within itself the functions of feed water heater, receiver, automatic make-up water regulator, and independent oil separator, that is, the oil separator attached to and forming a part of the heater is of sufficient capacity to purify of oil all the steam exhausted by the engine, including that used in the heating system.

This saves buying an independent oil separator and the trap, valves, tees, elbows and other fittings required for its installation. Valves incorporated in the construction permit of cutting the body of the heater out of communication, while the separator continues to purify the steam passing to the heating system. These valves are connected to one lever, and there is no possibility of throwing pressure on the heater or of stalling the engines, as sometimes happens where an independent separator is installed in a by-pass.

The owner of a large factory told us the other day that since he had put in an exhaust steam heating system, his bills for lighting, power and heating were not as large as the bills for heating alone when he used live steam for the purpose, and that his buildings were satisfactorily heated in the coldest weather. Perhaps you can make savings as great or even greater. Send us particulars about your plant and we shall be pleased to advise you.

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CLASSIFIED INDEX *to* ARTICLES ADVERTISED

Air Compressors

Allis-Chalmers Co.....116
Ingersoll-Rand Co.....114
Laidlaw-Dunn-Gordon Co....114
Union Steam Pump Co.....104

Alarms, Low Water

Detroit Lubricator Co..... 80
Lunkenheimer Co..... 4
Reliance Gauge Column Co...106
Wright Mfg. Co..... 92

Alternators

Allis-Chalmers Co.....116
General Electric Co..... 76

Asbestos Goods and Materials

Johns-Manville Co., H. W.... 79
McCord Mfg. Co..... 99

Belt Dressing

Cling-Surface Co. 101
Garlock Packing Co..... 6
Keystone Lubricating Co.... 3
Schieren Co., Chas. A.....100
Smooth-On Mfg. Co..... 6
Walton Co., F. S.....16 and 17

Belt Fasteners

Bristol Co.....4th cover
Stone Co., J. B.....100

Belt Lace

Schieren Co., Chas. A.....100

Belting

Bowers Rubber Works..... 98
Bristol Co.....4th cover
Diamond Rubber Co..... 98
Garlock Packing Co..... 6
Jeffrey Mfg. Co..... 97
New York Belting & Pack. Co. 10
Peerless Rubber Mfg. Co..... 8
Schieren Co., Chas. A.....100

Blocks, Chain

Yale & Towne Mfg. Co.....110

Blowers, Fan

Ohio Blower Co..... 91
Sturtevant Co., B. F.....110
Turbo-Blower Co..... 80
Wing Mfg. Co., L. J..... 94

Blowers, Steam Jet

McClave-Brooks Co..... 12
Parson Mfg. Co..... 94

Boiler Compound

Dearborn Drug and Chemical Works 5
Johns-Manville Co., H. W.... 79
Keystone Lubricating Co.... 3
Liberty Mfg. Co..... 7

Boiler Fronts

Casey-Hedges Co.....107
Treadwell Co., M. H..... 97

Boiler Setting

Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Boiler Tube Cap Reseating Machines

Elliott Co. 7

Boilers

Ames Iron Works.....116
Babcock & Wilcox Co.....107
Beggs & Co., James.....105
Casey-Hedges Co.....107
Griffith & Wedge Co.....117
Griscom-Spencer Co. 103
Harrisburg Foundry & Mach. Works 114
Harrison Safety Boiler Wks.. 67
Hawkes Boiler Co.....108
Heine Safety Boiler Co.....108
Hewes & Phillips Iron Wks...116
Houston, Stanwood & Gamble.110
Keeler Co., E.....108
Kingsford Fdry. & Mach. Co..108
Minneapolis Steel & Mchy. Co.113
Morrin Climax Boiler Co.....107
New Bedford Valve Mfg. Co.. 86
Oil City Boiler Works..... 84
Robb Engineering Co., Ltd...107
Struthers-Wells Co.....113
Vilter Mfg. Co.....116
Vogt Machine Co., Henry....107
Wickes Boiler Co.....108
York Mfg. Co.....110

Books

International Text Book Co.. 73
McGraw-Hill Book Co..... 74

Brick, Fire

Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Calorimeters

Schaeffer & Budenberg Mfg. Co. .....4th cover

Castings, Brass and Iron

Bruce-Macbeth Eng. Co.....112
Builders Iron Foundry.....111
Hooven, Owens, Rentschler Co.117
Lunkenheimer Co., The..... 4
McClave-Brooks Co..... 12
Neemes Bros..... 97
Ohio Brass Co..... 87
Salamander Grate Bar Co.... 97
Treadwell Co., M. H..... 97

Castings, Steel

Hooven, Owens, Rentschler Co.117
Treadwell Co., M. H..... 97

Cement, Iron

Johns-Manville Co., H. W.... 79
Smooth-On Mfg. Co..... 6

Cement, Rubber

Peerless Rubber Mfg. Co..... 8

Chimneys, Brick

Kellogg Co., M. W..... 90

Chimneys, Steel

Keeler Co., E.....108
Morrin Climax Boiler Co.....107
Treadwell Co., M. H..... 97

Clocks

American Steam Gauge and Valve Mfg. Co.....64 and 65

Clutches, Friction

Allis-Chalmers Co.....116
Williams Fdry. & Mach. Co.. 98

Cocks, Blow-off

Elliott Co..... 7
Hancock Inspirator Co..... 83

Cocks, Gage

American Steam Gauge and Valve Mfg. Co.....64 and 65
Huyette Co., Paul B..... 89
Jenkins Bros..... 69
Lunkenheimer Co., The..... 4
Ohio Blower Co..... 91
Ohio Brass Co..... 97
Reliance Gauge Column Co...106
Wright Mfg. Co..... 90

Cocks, Steam

Dart Mfg. Co., E. M..... 86
Lunkenheimer Co..... 4
National Tube Co..... 86
Schutte & Koerting Co..... 96

Combustion Recorders

Precision Instrument Co.....106

Compound, Commutator

Acheson Graphite Co., International 82
Dixon Crucible Co., Jos..... 80

Condensers

Alberger Condenser Co.....104
Allis-Chalmers Co.....116
Anderson Co., V. D..... 93
Baragwanath & Son, Wm....102
Cameron Steam Pump Works, A. S.....104
Epping-Carpenter Co.....104
Griscom-Spencer Co. 103
Kellogg Co., M. W..... 90
Minneapolis Steel & Mchy. Co.113
Schutte & Koerting Co..... 96
Union Steam Pump Co.....104
Wheeler Mfg. Co., C. H.....104

Controllers, Electric

General Electric Co..... 76
Westinghouse Elec. & Mfg. Co.118

Controllers, Feed Water

Mason Regulator Co..... 86
Northern Equipment Co.....106
Squires Co., C. E..... 90
Ziermore Regulator Co..... 87

Cooling Plants

Schutte & Koerting Co..... 96

Cooling Towers

Wheeler Mfg. Co., C. H.....104

Cordage

American Mfg. Co.....100
Columbian Rope Co.....100

Correspondence Schools

International Textbook Co... 73

Couplings, Flexible Shaft

Bruce-Macbeth Engine Co.....112
Hooven, Owens, Rentschler Co.117

Couplings, Pipe

Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7

Coverings, Pipe and Boiler

Johns-Manville Co., H. W.... 79

Cranes

Yale & Towne Mfg. Co..... 78

Die Stocks

Armstrong Mfg. Co..... 89
Bignall & Keeler Mfg. Co.... 89
Curtis & Curtis Co..... 89
Toledo Pipe Threading Mach. Co. 88

Draft, Mechanical

Parson Mfg. Co..... 94
Schutte & Koerting Co..... 96
Turbo-Blower Co..... 80
Wing Mfg. Co., L. J..... 94

Drills, Upright

Barnes Co., W. F. & John....107

Dust Collectors

Ohio Blower Co..... 90
Sturtevant Co., B. F.....110

Dynamos

Allis-Chalmers Co.....116
American Engine Co.....115
Bruce-Macbeth Eng. Co.....112
Fort Wayne Electric Works..112
General Electric Co..... 76
Ridgway Dynamo and Engine Co. 115
Sturtevant Co., B. F.....110
Westinghouse Elec. & Mfg. Co.118

Ejectors

Beggs & Co., James.....105
Hayden & Derby Mfg. Co.... 83
Lunkenheimer Co..... 4
Penberthy Injector Co.....113
Schutte & Koerting Co..... 96

Electric Current

New York Edison Co.....106

Engine Stops

Schutte & Koerting Co..... 96

Engines, Combustion

Ajax Iron Works..... 11
Allis-Chalmers Co.....116
Bogart Gas Power Engineering Co. 113
Bruce-Macbeth Eng. Co.....112
Buckeye Engine Co.....117
Du Bois Iron Works.....113
Elyria Gas Power Co.....113
Foos Gas Engine Co.....110
Mietz Iron Fdry. & Machine Works, August..... 84
Minneapolis Steel & Mchy. Co.113
Struthers-Wells Co.....113
Turner-Fricke Mfg. Co.....112
Westinghouse Elec. & Mfg. Co..118

Engines, Steam

Allis-Chalmers Co.....116
American Eng. Co.....115
Ames Iron Works.....116
Ball & Wood Co.....115
Ball Engine Co.....115
Beggs & Co., James.....105
Brownell Co.....108
Buckeye Engine Co.....117
Cooper Co., C. & G.....115
Du Bois Iron Works.....113
Erie Mfg. & Supply Co.....102
Fitchburg Steam Engine Co.. 115

Engines, Steam—*Continued.*

Griffith & Wedge Co.....117
Griscom-Spencer Co. 103
Harris Steam Eng. Co., Wm. A.116
Harrisburg Fdry & Mach. Wks.114
Hewes & Phillips Iron Wks..116
Hooven, Owens, Rentschler Co.117
Houston, Stanwood & Gamble Co. 110
McIntosh, Seymour & Co....115
Minneapolis Steel & Mchy. Co.113
Nagle Corliss Engine Works..115
Providence Engineering Wks.117
Ridgway Dynamo & Engine Co.115
Rollins Engine Co.....114
Skinner Engine Co.....117
Sturtevant Co., B. F.....110
Vilter Mfg. Co.....116
Watts, Campbell Co.....116
York Mfg. Co.....110

Exhaust Heads

Burt Mfg. Co..... 18
Hoppes Mfg. Co.....103
Ohio Blower Co..... 91
Patterson & Co., Frank L....102
Robertson & Sons, Jas. L....102
Ruggles Co., Walter G..... 86
Sturtevant Co., B. F.....110
Whitlock Coil Pipe Co..... 88
Wright Mfg. Co..... 92

Expansion Joints

Alberger Condenser Co.....104
National Tube Co..... 86

Fans, Electric

General Electric Co..... 76
Fort Wayne Electric Works..112
Westinghouse Elec. & Mfg. Co.118

Fans, Exhaust and Ventilating

Anderson Co., V. D..... 93
General Electric Co..... 76
Power Specialty Co..... 98
Sturtevant Co., B. F.....110
Turbo-Blower Co..... 80
Westinghouse Elec. & Mfg. Co.118
Wing Mfg. Co., L. J..... 94

Feeders, Furnace

Kennicott Co., The.....107
Ohio Blower Co..... 91

Filters, Oil

Burt Mfg. Co..... 18
Elliott Co. 7
Liberty Mfg. Co..... 7
Richardson-Phenix Co..... 78
Robertson & Sons, Jas. L.... 75
Ruggles Co., Walter G..... 86
Wright Mfg. Co..... 92

Filters, Water

Griscom-Spencer Co. 103
Scaife & Sons Co., Wm. B....107

Firebox Blocks

Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Fittings, Ammonia

American Steam Gauge and Valve Mfg. Co.....64 and 65
York Mfg. Co.....110

Fittings, Steel

Nelson Valve Co..... 85

Flanges

Ball & Wood Co.....115
Dart Mfg. Co., E. M..... 86
Jefferson Union Co.. 14
National Tube Co..... 86

Floats

Anderson Co., V. D..... 93
Schutte & Koerting Co..... 96

Flue Gas Analysis Instruments

Pierce Co., Wm. B.....2d cover

Fuel Economizers

Parsons Mfg. Co..... 94
Sturtevant Co., B. F.....110

Furnace Door Arch

Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

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Furnaces, Smokeless

McClave-Brooks Co..... 12
Murphy Iron Works..... 97

Gage Boards

American Steam Gauge and Valve Mfg. Co.....64 and 65

Gage Glasses

American Steam Gauge and Valve Mfg. Co.....64 and 65
Ashcroft Mfg. Co..... 83
Chesterton Co., A. W..... 86
Garlock Packing Co..... 9
Peerless Rubber Mfg. Co..... 8

Gage Testing Outfit

American Steam Gauge and Valve Mfg. Co.....64 and 65

Gages, Draft

American Steam Gauge and Valve Mfg. Co.....64 and 65
Bristol Co.....4th cover
Schaeffer & Budenberg Mfg. Co. .....4th cover

Gages, Pressure

American Steam Gauge and Valve Mfg. Co.....64 and 65
Ashton Valve Co..... 89
Crosby Steam Gage & Valve Co. 87
Schaeffer & Budenberg Mfg. Co. .....4th cover

Gages, Recording

American Steam Gauge and Valve Mfg. Co.....64 and 65
Ashton Valve Co..... 89
Bristol Co.....4th cover
Schaeffer & Budenberg Mfg. Co. .....4th cover
Uehling Instrument Co.....107

Gages, Vacuum

American Steam Gauge and Valve Mfg. Co.....64 and 65
Schaeffer & Budenberg Mfg. Co. .....4th cover
Schutte & Koerting Co..... 96

Gages, Water

American Steam Gauge and Valve Mfg. Co.....64 and 65
Greene, Tweed & Co., 82 and 4th cover
Huyette Co., Paul B..... 89
Jenkins Bros..... 69
Lunkenheimer Co..... 4
Ohio Blower Co..... 91
Reliance Gauge Column Co...106
Wright Mfg. Co..... 90

Gas Exhausters

Ohio Blower Co..... 91

Gas Producers

Bogart Gas Power Engineering Co. 113
Du Bois Iron Works.....113
Foos Gas Engine Co.....110
Griscom-Spencer Co.....103
Minneapolis Steel & Mchy. Co.113

Gaskets

Akron Metallic Gasket Co.... 78
American Goetze-Gasket and Packing Co.....1st cover
Cancos Mfg. Co..... 97
Diamond Rubber Co..... 98
Eureka Packing Co..... 71
Garlock Packing Co..... 9
Greene, Tweed & Co., 82 and 4th cover
Jenkins Bros..... 69
Johns-Manville Co., H. W.... 79
Keeler Co., E.....108
National India Rubber Co.... 98
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co..... 8

Gears

New Process Raw Hide Co...100

Generating Sets

American Engine Co.....115
Foos Gas Engine Co.....110
Fort Wayne Electric Works..112
General Electric Co..... 76
Harris Steam Engine Co., Wm.116
Harrisburg Foundry and Machine Works.....114
Ridgway Dynamo & Engine Co.115
Sturtevant Co., B. F.....110
Westinghouse Elec. & Mfg. Co.118

Governors, Pump

Foster Engineering Co..... 88
Mason Regulator Co..... 86
Northern Equipment Co.....106

Governors, Pump—*Continued.*

Squires Co., C. E..... 90
Watson & McDaniel Co.....103
Ziermore Regulator Co..... 79

Governors, Pump Speed

Mason Regulator Co..... 86
Ziermore Regulator Co..... 79

Graphite

Acheson Graphite Co., International 82
Dixon Crucible Co., Jos..... 80
Garlock Packing Co..... 9

Grates

Casey-Hedges Co.....107
Long Grate Bar Co..... 84
McClave-Brooks Co..... 12
Neemes Bros..... 97
Perfection Grate Co..... 97
Salamander Grate Bar Co.... 97
Standard Grate Co..... 92
Treadwell Co., M. H..... 97
Washburn & Granger Co..... 97

Grease

Acheson Graphite Co., International 82
Albany Lubricating Co..... 81
Cataract Refining & Mfg. Co.. 81
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos..... 80
Kellogg & Co., E. H..... 80
Keystone Lubricating Co..... 3
Philadelphia Grease Co..... 82
Walton Co., F. S.....16 and 17

Grease Cups

Universal Lubricating Co..... 15

Grease Extractors

Beggs & Co., James.....105
Griscom-Spencer Co.....103

Heaters and Purifiers, Feed Water

Alberger Condenser Co.....104
Baragwanath & Son, Wm.....102
Blake & Knowles Steam Pump Works 98
Casey-Hedges Co.....107
Erie Mfg. & Supply Co.....102
Griscom-Spencer Co.....103
Harrison Safety Boiler Wks.. 67
Hoppes Mfg. Co.....103
Minneapolis Steel & Mchy. Co.113
National Pipe Bending Co....102
Open Coil Heater & Purifier Co. 93
Patterson & Co., Frank L....102
Robertson & Sons, Jas. L.... 75
Wheeler Mfg. Co., C. H.....104
Whitlock Coil Pipe Co..... 88
Wickes Boiler Co.....108
Wilkinson Fdry. & Mfg. Co... 94
Williams Tool Co.....102

Heating and Ventilating Systems

Ohio Blower Co..... 91
Schutte & Koerting Co..... 96
Wing Mfg. Co., L. J..... 94

Heating, Central Station

American District Steam Co..111

Hoists, Electric

Allis-Chalmers Co.....116
Yale & Towne Mfg. Co..... 78

Hoists, Hand

Yale & Towne Mfg. Co..... 78

Hose, Metal

American Metal Hose Co.....106
Pennsylvania Flexible Metallic Tubing Co..... 86

Hose, Rubber

Diamond Rubber Co..... 98
Garlock Packing Co..... 9
Lagonda Mfg. Co.....3d cover
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co..... 8
Pennsylvania Flexible Metallic Tubing Co..... 86

Ice and Refrigerating Machinery

Vogt Machine Co., Henry....107
York Mfg. Co.....110

Indicators, Ammonia

American Steam Gauge and Valve Mfg. Co.....64 and 65

Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co.....64 and 65
Ashcroft Mfg. Co..... 83
Schaeffer & Budenberg Mfg. Co.....4th cover
Trill Indicator Co..... 78

Indicators, Speed

Schaeffer & Budenberg Mfg. Co.....4th cover
Starrett Co., L. S.....102

Indicators, Steam Engine

American Steam Gauge and Valve Mfg. Co.....64, 65
Ashcroft Mfg. Co..... 83
Crosby Steam Gage & Valve Co. 87
Robertson & Sons, Jas. L.... 75
Schaeffer & Budenberg Mfg. Co.....4th cover
Trill Indicator Co..... 78

Injectors

Hayden & Derby Mfg. Co.... 83
Jenkins Bros..... 69
Lunkenheimer Co..... 4
Penberthy Injector Co..... 13
Robertson & Sons, Jas. L.... 75
Schutte & Koerting Co..... 96

Lamps, Acetylene

Simmons Co., John..... 95

Lamps, Electric

General Electric Co..... 76
Johns-Manville Co., H. W.... 79
Westinghouse Elec. & Mfg. Co. 118

Lathes, Foot Power

Barnes Co., W. F. & John....107

Lubricators, Cylinder

Detroit Lubricator Co..... 80
Greene, Tweed & Co., 82 and 4th cover
Griscom-Spencer Co.....103
Lunkenheimer Co..... 4
Manzel Bros. Co..... 81
Robertson & Sons, Jas. L.... 75
Richardson-Phenix Co..... 78
Universal Lubricator Co..... 15

Lubricators, Force Feed

Lunkenheimer Co..... 4
McCord Mfg. Co..... 99
Richardson-Phenix Co..... 78

Mats and Matting

Diamond Rubber Co..... 98
New York Belting & Packing Co 10
Peerless Rubber Mfg. Co..... 8

Metal, Bearing

Leddell-Bigelow Co.....111
Magnolia Metal Co.....110

Meters, Steam

General Electric Co..... 76
St. John, G. C..... 110

Meters, Water

Builders Iron Foundry.....111

Micrometers

Starrett Co., L. S.....102

Milling Machines, Portable

Underwood & Co., H. B.....110

Motors, Electric

Allis-Chalmers Co.....110
American Engine Co.....115
Fort Wayne Electric Works..112
General Electric Co..... 76
Ridgway Dynamo & Engine Co 115
Sturtevant Co., B. F.....110
Westinghouse Elec. & Mfg. Co. 118

Motors, Water

Lagonda Mfg. Co.....3d cover

Oil and Grease Cups

Albany Lubricating Co..... 81
Detroit Lubricating Co..... 80
Keystone Lubricating Co.... 3
Liberty Mfg. Co..... 7
Lunkenheimer Co..... 4
New York & New Jersey Lubricant Co..... 80
Richardson-Phenix Co..... 78
Schaeffer & Budenberg Mfg. Co. .....4th cover
Universal Lubricating Co.... 15

Oil Burners

Hammel Oil Burner Co..... 78
Lunkenheimer Co..... 4
Parson Mfg. Co..... 94

Oil Reservoirs

Burt Mfg. Co..... 18
Richardson-Phenix Co..... 78

Oil Systems

Albany Lubricating Co..... 81
Burt Mfg. Co..... 18
Detroit Lubricator Co..... 80
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 78

Oils

Albany Lubricating Co..... 81
Dearborn Drug & Chemical Works 5
Kellogg & Co., E. H..... 80
New York & New Jersey Lubricant Co..... 80
Walton Co., F. S.....16 and 17

Packing, Flange

American Goetze-Gasket and Packing Co.....1st cover
Bowers Rubber Works..... 98
Cancos Mfg. Co..... 97
Chesterton Co., A. W..... 86
Diamond Rubber Co..... 98
Eureka Packing Co..... 71
Garlock Packing Co..... 9
Greene, Tweed & Co., 82 and 4th cover
Jenkins Bros..... 69
Johns-Manville Co., H. W.... 79
McCord Mfg. Co..... 99
National India Rubber Co... 86
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co.... 8
Smooth-On Mfg. Co..... 6
Thermoid Rubber Co..... 11

Packing, Hydraulic

Johns-Manville Co., H. W.... 79

Packing, Pump Valve

Cancos Mfg. Co..... 97
Diamond Rubber Co..... 98

Packing, Rod

American Goetze-Gasket and Packing Co.....1st cover
Cancos Mfg. Co..... 97
Chesterton Co., A. W..... 86
Diamond Rubber Co..... 98
Eureka Packing Co..... 71
Garlock Packing Co..... 9
Greene, Tweed & Co., 82 and 4th cover
Johns-Manville Co., H. W.... 79
National India Rubber Co.... 86
New York Belting and Packing Co. 10
Nugget Packing Co..... 97
Peerless Rubber Mfg. Co..... 8
Power Specialty Co..... 98
Steel Mill Packing Co..... 98
Thermoid Rubber Co..... 11
Tripp Metallic Packing Co... 98

Pipe

Ball & Wood Co.....115

Pipe Bending

Ball & Wood Co.....115
Kellogg Co., M. W..... 90
National Pipe Bending Co....102
Whitlock Coil Pipe Co..... 88

Pipe Clamp

Simplex Engineering Co..... 90

Pipe Coils

National Pipe Bending Co....102
National Tube Co..... 86
Whitlock Coil Pipe Co..... 88

Pipe Cutting and Threading Machines

Armstrong Mfg. Co..... 89
Bignall & Keeler Mfg. Co.... 89
Curtis & Curtis Co..... 89
Toledo Pipe Threading Machine Co..... 88
Treadwell Co., M. H..... 97
Trimont Mfg. Co..... 94

Piping, Blow

Ohio Blower Co..... 91

Piping, High Pressure

Kellogg Co., M. W..... 90

Planimeters

American Steam Gauge and Valve Mfg. Co.....64 and 65
Ashcroft Mfg. Co..... 83
Robertson & Sons, Jas. L.... 75

Polish, Metal

Hoffman, Geo. W.....104
Johns-Manville Co., H. W.... 79

Publishers

International Textbook Co.... 73
McGraw-Hill Book Co..... 74

Pulleys

Minneapolis Steel & Mchy. Co.113